

DOCUMENT RESUME

ED 297 975

SE 049 476

TITLE Occupationally Related Science. Draft Curriculum
1986-87.

INSTITUTION New York State Education Dept., Albany. Div. of
Occupational Education Programs.

PUB DATE 86

NOTE 114p.

PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC05 Plus Postage.

DESCRIPTORS *Biological Sciences; Chemistry; Course Content;
*Course Descriptions; Instructional Materials;
Integrated Curriculum; *Occupational Safety and
Health; *Physical Sciences; Physics; Science
Education; *Science Instruction; Secondary Education;
*Secondary School Science; Vocational Education

ABSTRACT

To prepare occupational students for employment, a basic understanding of scientific knowledge and the processes of science that have been applied in the development of tools, machines, instruments, and technological techniques or processes should be taught. When a second unit of science was included for all high school students in the New York State Regents Action Plan, an option for a specific science course devoted to the practical application of scientific concepts was approved for occupational students. This syllabus was initiated because science learned in the process of acquiring an occupational preparation can be related to the knowledge needs of workers and consumers. Specific performance objectives and suggested instructional strategies are identified. Topics included in this syllabus are: (1) "Health Science and Safety" (including The Healthy Worker and The Safe Worker); (2) "Physics Applications" (including Mechanics, Wave Motion and Energy Relationships, Hydraulics and Pneumatics, and Energy in Electricity and Magnetism); (3) "Chemical and Material Science Applications" (including Chemical Technology, Chemical Reactions, Chemical Hazards, and Materials Science/Testing); and (4) "Life Science Applications" (including Spheres of the Ecosystem, Cycles of the Ecosystem, Energy Flow in an Ecosystem, and Human Ecological Relationships and Adaptations). (CW)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED 297975

OCCUPATIONALLY RELATED SCIENCE



U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

This document has been reproduced as
received from the person or organization
originating it.

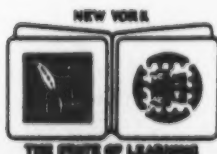
Minor changes have been made to improve
reproduction quality.

Points of view or opinions stated in this docu-
ment do not necessarily represent official
OERI position or policy.

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

*William
Blumley*

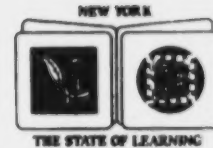
TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."



DRAFT

The University of the State of New York
The State Education Department
Office of Occupational and Continuing Education
Division of Occupational Education Programs
Albany, New York 12234

BEST COPY AVAILABLE



THE STATE EDUCATION DEPARTMENT / THE UNIVERSITY OF THE STATE OF NEW YORK / ALBANY, N.Y. 12234

ASSISTANT COMMISSIONER FOR OCCUPATIONAL AND CONTINUING EDUCATION
THE NEW YORK STATE EDUCATION DEPARTMENT
ALBANY, NEW YORK 12234

OCE # 33

August 1986

TO: District Superintendents of Schools
Superintendents of Public and Nonpublic High Schools
Principals of Public and Nonpublic High Schools
New York City Board of Education
Directors of Occupational Education

FROM: James A. Kadamus, Assistant Commissioner

SUBJECT: Occupationally Related Science Syllabus

The draft syllabus for Occupationally Related Science was developed to assist local agencies in offering occupational education instruction consistent with the Regents Action Plan and Part 100 of the Commissioner's Regulations.

According to the Action Plan and Regulations, Occupationally Related Science may be used to meet the second unit of science required for a local diploma by students pursuing a sequence in occupational education. A course in Occupationally Related Science provides an option for occupational education students to develop skills in their desired occupational choice, as well as meet the science requirement. Commissioner's Regulations Part 100.5(d)(3)(ii), requires that courses in Occupationally Related Science which are used by occupational education students to meet the second unit requirement in science, "shall be taught in accordance with the appropriate State syllabi." Use of this draft syllabus fulfills that requirement.

This syllabus is a revision of the version distributed in October 1985. The revision reflects the advice of teachers who have used and reviewed the initial document. Our office will continue to solicit suggestions for improving the draft syllabus and will revise it as needed.

If you have any questions on this syllabus, or would like to provide suggestions for improvement, please contact:

Richard D. Jones, Chief
Bureau of Occupational Education Program Development
One Commerce Plaza, Room 1623
Albany, New York 12234
(518) 474-4806

OCCUPATIONAL EDUCATION

Draft Curriculum
1986-87

OCCUPATIONALLY RELATED SCIENCE

Modules: Health Science and Safety
Physics Applications
Chemical and Material Science Applications
Life Science Applications

The State Education Department does not discriminate on the basis of age, color, creed, disability, marital status, national origin, race, or sex in the educational programs and activities which it operates. This policy is in compliance with Title IX of the Education Amendments of 1972. Inquiries concerning this policy may be referred to the Department's Affirmative Action Officer, Education Building, Albany, NY 12234.

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Division of Occupational Education Programs

OCCUPATIONALLY RELATED SCIENCE FOREWORD

A knowledge of science is integral to every occupational student's preparation. Science, however, is not just "things" but a process by which we learn new information. This syllabus combines these aspects.

To prepare occupational students for employment, they must understand basic scientific knowledge and the processes of science that have been applied in the development of tools, machines, instruments, and technological techniques or processes.

When a second unit of science was included for all high school students in the Regents Action Plan, an option for a specific science course devoted to the practical application of scientific concepts, was approved for occupational students. This syllabus was initiated because science learned in the process of acquiring an occupational preparation can be directly related to the knowledge needs of workers and consumers.

This option has been fulfilled in this Occupationally Related Science syllabus with specific performance objective and suggested instructional strategies. The following are educators who contributed to its development.

BRUCE BONESTEEL, **Salmon River Central School**; ODILIA BURLEE, **Wayne-Finger Lakes Area Occupational Center**; REID DOE, **Penfield High School**; C. DAVID GIERKE, **West Seneca East High School**; BRADFORD HAGUE, **Queensbury High School**; EUNICE HARTMAN, **Penfield High School**; GLENN HIDER, **West Virginia University**; THEODORE MULLEN, **Phelps Clifton Springs High School**; DANIEL A. NELSON, **Shenendehowa High School**; DAVID REAGON, **Webtuck High School**; ROYCE ROGERS, **Fairport Central Schools**; NANCY WILL, **Vestal Central School**; JAMES YAHNITE, **Geneva High School**

The final draft of the syllabus was edited by PATRICIA PIETROPAOLO, **Community College of the Finger Lakes**, and RONALD STEWART, **Atmospheric Science Research Center, State University of New York, Albany**.

OCCUPATIONALLY RELATED SCIENCE

TABLE OF CONTENTS

	Page
Syllabus Overview.	1
Core Outline	4
Modules:	
Health Science and Safety.	12
The Healthy Worker	18
The Safe Worker	25
Physical Science Applications	38
Mechanics	44
Wave Motion and Energy Relationships	49
Hydraulics and Pneumatics	54
Electricity and Magnetism	57
Chemical and Material Science Applications	63
Chemical Terminology	66
Chemical Reactions	71
Chemical Hazards.	77
Materials Science/Testing	83
Life Science Applications	87
Spheres of the Ecosystem	94
Cycles of the Ecosystem	99
Energy Flow in an Ecosystem	104
Human Ecological Relationships and Adaptations	109

OCCUPATIONALLY RELATED SCIENCE

SYLLABUS OVERVIEW

GOAL

The Occupationally Related Science syllabus is designed to broaden and deepen the student's knowledge of scientific principles and processes developed in Science (grades 7-9) and to relate and apply these principles to occupational experiences. Students should be able to determine the relevance of each scientific concept and corresponding application to their occupational area. Wherever appropriate, the student should be involved in hands-on laboratory activities that enhance the scientific concepts presented.

CONTENT

The Occupationally Related Science syllabus is a one-unit course designed to meet the needs of occupational students in fulfilling the required second unit of science. The syllabus is divided into four modules.

Each occupationally related science course must include the core content (estimated minimum teaching time of 27 hours) from the Health Science and Safety module. The course must also include the core content (estimated minimum teaching time of 27 hours) from any one of the following three modules: Physics Applications, Chemical and Material Science Applications, Life Science Applications. The remaining instruction (estimated minimum teaching time of 54 hours) to fulfill the one unit of study requirement (minimum of 108 hours) may be composed of material from any of the four modules appropriate to student's needs in their selected occupational preparation. The modules may be taught in any order.

An overview of each of the four modules is provided below.

Health Science and Safety. Normal and abnormal human body functions are related to occupational and life experiences. Stress is placed on preventive measures to ensure safe practices in and out of the work environment, and on emergency treatment for situations where unsafe practices have resulted in injuries.

Physics Applications. Physical science concepts are presented in four major topics: Mechanics, Wave Motion and Energy Relationships, Hydraulics and Pneumatics, and Electricity and Magnetism. Content should be enhanced to meet specific occupational needs, to create more interested and effective workers, and to explain everyday experiences.

Chemical and Material Science Applications. Chemical science develops an understanding of basic chemical terminology and of chemical reactions that occur in occupational and life situations. The impact of hazardous chemicals is explored. Material science and testing concepts are introduced, based on physical properties.

Life Science Applications. An holistic view is presented of plants and animals and their relationship to the environment. Emphasis is placed on the relationship of each component to the total system and on the environment in the development of appropriate occupational and consumer choices regarding the utilization of plant and animal resources.

OCCUPATIONALLY RELATED SCIENCE

INSTRUCTION

Scientific concepts identified by staff and consultants of the New York State Education Department and tested by the Regents Competency Test should be expanded and broadened in this syllabus. Hands-on laboratory activities are strongly encouraged to enhance scientific concepts as they are presented. Because the content in this syllabus builds upon previously acquired science understandings and inquiry, occupational education teachers should familiarize themselves with the "guide" to the Regents Competency Test in Science and the appropriate middle and junior high school science syllabi:

Life Sciences	Blocks A-C
Earth Sciences	Blocks D-F
Physical Sciences	Blocks G-I
Science, Technology, and Society	Block J

Students should be prepared to deal with situations in the adult world that require effective problem solving and decision making. It is important, therefore, that students be given the opportunity to solve problems and make decisions as part of this science instruction. Experiences should be provided to make students aware of discrepancies, to raise questions, and to seek answers. A model for problem solving and decision making can be found in the State Education Department's Elementary Science Syllabus (1985), and the Middle and Junior High School Science Syllabus: Science, Technology, and Society, Block J.

DELIVERY AND CREDIT

The content of this syllabus may be provided at the local high school or at a BOCES facility. Presentation of the syllabus content can be accomplished through a variety of techniques. Content may be presented as an independent, free-standing course, or by infusing content and time requirements into another occupational program. A combination of these approaches may also be used. If infusion is to be used, the total time for the sequence must be increased the equivalent of one unit to accommodate the added required times for science.

Course content must represent a unit of study of at least 180 minutes of instruction per week, or its equivalent, throughout the school year.

An occupational education student seeking a local diploma may use Occupationally Related Science to obtain the second unit of science credit needed to meet graduation requirements. Occupationally Related Science may also be used as a part of an occupational sequence if the science unit is designated as an integral part of the sequence, and simultaneously as a unit in a science sequence.

CORE CONTENT/SYLLABUS

Each Occupationally Related Science course must contain the core content from the Health Science and Safety Module and from one additional module.

CORE CONTENT/MODULES

Core content for each module is identified in the Core Outline presented as part of the syllabus overview. The Core Outline identifies the basic topics that are required for each module.

Also, core content for each module is identified by an (*) within the expanded outline of each module. The expanded module outlines provide suggested avenues of enhancement for the required core content. What is taught beyond the core content is to be determined by the instructor, based on the needs of the student population.

The major core topics for each module (those with capital letters in the Core Outline and Module Outline) are identified as the Skills, Knowledge and Behaviors to be Developed for each module. They are listed in the overview of each module and also at the beginning of each topic within the module.

The Performance Objectives and Suggested Instructional Strategies for each topic correspond directly to the Skills, Knowledge and Behaviors to be Developed in each topic. The Suggested Instructional Strategies are offered only as suggestions for achieving the performance objectives. Instructors are expected to establish programs by adding their own activities which will accomplish the goal of the syllabus.

TESTING

No state test or examination is required in order to receive credit for Occupationally Related Science. Sample test items may be available in the future to be used as a resource in developing local examinations.

PREREQUISITE

Successful completion of one year of high school science is a course prerequisite. (Note: A student who has failed the Regents Competency Test (RCT) in science may enroll in Occupationally Related Science for the second year of science, but the course is not meant to be remedial. However, while not designed to fulfill remediation requirements, the Commissioner's Regulation 100 regarding remediation should be reviewed to determine if adjustments in course delivery, such as reduced class size, might be implemented to meet remediation requirements.)

CREDIT FOR REGENTS DIPLOMA

An Occupationally Related Science course may be developed locally which can be offered for Regents diploma credit. Such a course must be developed by local educators to the same degree of rigor as Regents science courses, accompanied by an examination and submitted to the State Education Department for approval. Staff within occupational education as well as science education will review all proposed syllabi and examinations. Proposals should be addressed to:

Edward Lalor, Director
Division of Program Development
Room 314C, State Education Building
Albany, New York 12234
(518) 474-5897

OCCUPATIONALLY RELATED SCIENCE

OCCUPATIONALLY RELATED SCIENCE: CORE OUTLINE

The Core Outline identifies required topics and subtopics for the Occupationally Related Science syllabus. Each topic corresponds to the specific Skills, Knowledge, or Behaviors and a Performance Objective in the individual modules. The topics of the module Health Science and Safety are required for each course. The topics of one of the three remaining modules must be taught entirely. The remaining two modules not selected as core may be used as appropriate for the students. A more detailed outline is included at the beginning of each module and specific core topics are preceded by an asterisk (*).

Health Science and Safety

- I. The Healthy Worker
 - A. Normal functioning of body systems
 1. Circulatory
 2. Respiratory
 - B. Abnormal functioning of body systems
 - C. Need for basic health assessment
 - D. Basic health assessment techniques
 1. General Survey
 - a. Signs of distress
 - b. Dress, grooming, personal hygiene
 - c. Manner, mood, and relationship to persons and things in the environment
 2. Circulatory System
 - a. Blood pressure
 3. Respiratory system
 - a. Vital capacity
- II. The Safe Worker
 - A. Categories of health and safety hazards
 1. Chemical hazards
 - a. Fibers
 - b. Liquids
 - c. Gases
 - d. Vapors
 2. Physical hazards
 - a. Noise
 - b. Vibration
 - c. Radiation
 - d. Lighting
 - e. Ventilation
 - f. Space
 - g. Environment
 - h. Motion
 - i. Electricity
 - j. Temperature
 - k. Height
 - l. Surface condition
 - m. Climate
 3. Personal health hazards
 - a. Drugs
 - b. Stress
 - c. Fatigue

OCCUPATIONALLY RELATED SCIENCE

Core Outline (continued)

Health Science and Safety, continued

- d. Infection
- e. Lack of sanitation
- B. Effects of health and safety hazards on the body
- C. Monitoring health and safety hazards
- D. Standards for health and safety hazards
- E. Control techniques for health and safety hazards
- F. Personal protective equipment (for)
 - 1. Eyes and face
 - 2. Ears
 - 3. Head
 - 4. Hands and arms
 - 5. Feet and legs
 - 6. Respiratory system
 - 7. Trunk
- G. Situations affected by body stance and position
 - 1. Striking against something
 - 2. Being struck by something
 - 3. Being caught between objects
 - 4. Falling
- H. Actions of people
 - 1. Adjusting personal protective equipment
- I. Tools and equipment
 - 1. Appropriate
- J. Safety rules
 - 1. Adequate
 - 2. Understood
 - 3. Reviewed
- K. Emergency procedures
 - 1. Reporting accidents
 - 2. For reducing hazards

Physics Applications

- I. Mechanics
 - A. Force
 - 1. Definition
 - 2. Measurement of force
 - B. Motion
 - 1. Relationship between force and motion
 - C. Work
 - 1. Simple machines
 - a. What machines do
 - b. Types of machines
 - c. Mechanical advantage
 - d. Efficiency
 - D. Energy
 - 1. Kinds
 - a. Potential
 - b. Kinetic

OCCUPATIONALLY RELATED SCIENCE

Core Outline (continued)

Physics Applications, continued

2. Forms/sources
 - a. Mechanical
 - b. Gravitational
 - c. Chemical
 - d. Heat
 - e. Electrical
 - f. Magnetic
 - g. Nuclear
 - h. Electromagnetic
- II. Wave Motion and Energy Relationships
 - A. The Nature of waves
 1. Types of waves
 - a. Transverse
 - b. Longitudinal
 2. Characteristics of waves
 - B. Sound
 1. Sounds in the environment
 2. Sounds in occupations
 - C. Light
 1. Transverse wave
 2. Sound vs. light
 3. Sources of light
 4. Instruments for the measurement of light intensity
- III. Hydraulics and Pneumatics
 - A. Definitions
 - B. Principles
 1. Mechanical advantage
 - C. Applications
 1. Movement of fluids, levers and motors
- IV. Energy in Electricity and Magnetism
 - A. Static electricity
 1. Definitions
 2. Insulators and conductors
 - B. Electric currents
 1. Definitions
 2. Appliances change electrical energy to other forms of energy
 - C. Magnetism
 1. The magnetic poles and forces
 - D. Applications of magnetism and electricity
 1. Electric generators
 2. Electromagnetism

OCCUPATIONALLY RELATED SCIENCE

Core Outline (continued)

Chemical and Material Science Applications

I. Chemical Terminology

- A. Elements
 - 1. Metals
 - 2. Nonmetals
 - 3. Metalloids
- B. Compounds
 - 1. Acids
 - 2. Bases
 - 3. Salts
 - 4. Organic substances
- C. Mixtures
 - 1. Solutions

II. Chemical Reactions

- A. Synthesis
 - 1. Oxidation
- B. Decomposition
 - 1. Hydrolysis
- C. Neutralization
 - 1. Acid and base
 - 2. Oxidizer and reducer
- D. Altering reactions
 - 1. Accelerators
 - a. Temperature
 - 2. Preventing reactions
 - a. Surface protection
 - b. Internal protection

III. Chemical Hazards

- A. Terminology
 - 1. Toxic, acute and chronic
 - 2. Hazardous
- B. Toxic doses/hazardous levels
 - 1. LD (lethal dose), LC (lethal concentration)
 - 2. TLV (threshold limit values)
 - 3. Standard hazardous chemical data
- C. Hazards in the workplace
 - 1. Organics and heavy metals
 - 2. Overexposure
- D. Fire classification and procedures for handling
 - 1. Class "A" fire
 - 2. Class "B" fire
 - 3. Class "C" fire
 - 4. Class "D" fire

OCCUPATIONALLY RELATED SCIENCE

Core Outline (continued)

Chemical and Material Science Applications, continued

IV. Materials Science/Testing

- A. Materials science fundamentals
 - 1. Using models
- B. Material structures and properties
 - 1. Structures
 - a. Gases
 - b. Liquids and solutions
 - c. Solids
 - 1) Crystals
 - 2) Metals and Alloys
 - 2. Properties
 - a. Mechanical
 - b. Electrical and magnetic
 - c. Thermal and chemical
 - d. Surface
- C. Materials testing

Life Science Applications

I. Spheres of the Ecosystem

- A. Organization of the biosphere
 - 1. Abiotic factors in an ecosystem
 - a. Light
 - b. Temperature
 - c. Precipitation
 - d. Soil
 - e. Minerals
- B. The lithosphere
 - 1. Rock cycle
 - a. Sedimentary rock
 - b. Sediments (soil)
 - 2. Soils
 - a. Soil development
- C. The hydrosphere
 - 1. The water cycle
 - a. Evaporation
 - b. Condensation
 - c. Precipitation
 - d. Subsurface water zones
 - 2. Water and life
 - a. World biomes and precipitation
 - b. Photosynthesis and water
 - c. Respiration and water

OCCUPATIONALLY RELATED SCIENCE

Core Outline (continued)

Life Science Applications, continued

II. Cycles of the Ecosystem

- A. Carbon and photosynthesis
 - 1. Carbon dioxide in the atmosphere
 - 2. Photosynthetic equation
 - 3. Consumption of plant carbohydrates by animals
 - 4. Respiration and decay
 - 5. Combustion
- B. Oxygen and respiration
 - 1. Oxygen in the atmosphere
- C. Nitrogen in amino acids
- D. Nitrogen cycle

III. Energy Flow of an Ecosystem

- A. The sun is the source of energy for ecosystems
 - 1. Energy requirement for metabolism
 - 2. Food chains
 - 3. Food webs
- B. Autotrophic nutrition
- C. Heterotrophic nutrition
- D. Food chains
- E. Energy pyramid
 - 1. Producers
 - 2. 1st-level consumers
 - 3. 2nd-level consumers
 - 4. 3rd-level consumers
 - 5. Relationship of biomass

IV. Human Ecological Relationships and Adaptations

- A. Carrying capacity and population growth
 - 1. Normal growth curve with carrying capacity
 - 2. Growth curve of human population
 - 3. Malthusian growth prediction
 - 4. Resource utilization
 - a. Renewable resources
 - b. Nonrenewable resources
 - c. Resource reclamation
- B. Conservation
 - 1. Water conservation
 - a. Watershed
 - b. Water and soil conservation
 - c. Aquifers and soil conservation
- C. Genetics
 - 1. Gene-chromosome theory
 - a. Chromosomes
 - b. Genes

OCCUPATIONALLY RELATED SCIENCE

PERFORMANCE STANDARDS

Each student should be expected to work to a standard acceptable to the teacher, the school district, and the State of New York. While it is unrealistic to set a specific standard for each performance objective, it is realistic to expect that there be a consensus on the level of these standards. For instance, the term "in keeping with trade standards" provides a guideline for each instructor within each specific trade. The American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. publishes the ASHRAE Handbook of Fundamentals that contains technical information it considers to be the standard for its profession. Each school should establish a grading policy that determines pass/fail, probation options, and other conditions.

To aid in determining the appropriate level of student performance, each area of occupational or academic specialization should refer to documents that represent the consensus of that area. The student's expected level of performance will also be limited by the instruments, tools, and other details presented by the teacher and used by the student. The performance standard should require that the student work at the level of tolerance of the particular instrument or machine and do so to the satisfaction of the instructor.

The literature accompanying an instrument or machine will usually indicate the level of tolerance. (The instructor's professional judgement should be used in determining the last decimal place required.)

The performance standard for calculations will be controlled by the accuracy of the input data. If the input data is in cents, then the output (answer) should be to the same accuracy.

The intent of these performance standards is to insure that the performance of the student reaches the physical limitations of the instrument (data, etc.) normally used in the subject studied and the student's future occupation. By following this standard, students will always be trained to the best of their ability and to the satisfaction of the instructor.

TESTING

No state test or examination will be required to receive credit for Occupationally Related Science. Sample test items may be available in the future for use as a resource in developing local examinations.

COURSE PREREQUISITE

Successful completion of one year of high school science is a required prerequisite. (Note: Students who have not passed the RCT in science may be enrolled in this State approved Occupationally Related Science for their second year of science. The syllabus is not intended to be remedial. A student must pass the RCT in science before receiving a local diploma.)

OCCUPATIONALLY RELATED SCIENCE

SYLLABUS ORGANIZATION

Each of the four modules of this syllabus is organized as indicated below.

Overview of the Module

- o Goal
- o Description
- o Skills, Knowledge, and Behaviors to be Developed
- o Content of the Module*
- o Estimated Minimum Teaching Time (for the Module)

Individual Topics

- o Goal
- o Description
- o Skills, Knowledge, and Behaviors to be Developed
- o Estimated Minimum Teaching Time (for the Topic)
- o Performance Objectives/Supporting Competencies
- o Suggested Instructional Strategies

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY

OVERVIEW OF THE MODULE

GOAL

Upon successful completion of this module, the student will recognize and deal appropriately with normal and abnormal body functioning. The student will also explore several occupational areas and identify and discuss their special health and safety concerns. Students will recognize unsafe, job-related situations and develop appropriate safety standards and practices.

DESCRIPTION

The Occupational Health Science and Safety module is a nine-week (27-hour) segment of the Occupational Science syllabus. The module is designed to introduce occupational education students to basic health and safety considerations important to productivity in the workplace and in the adult world. The module is divided into two topics, the Healthy Worker and the Safe Worker, that can vary in length and instructional time according to the identified needs of the student population. Each topic focuses on a particular aspect of health and/or safety that applies to survival in the workplace and in the adult world. Content is covered that is also found in Health Education and Health Occupation Education but it is not repetitious. Rather, a continuum of education is provided. Health Education looks from the personal and consumer point of view. Occupationally Related Science looks from the worker's point of view. Health Occupational Education looks from an assessment and health care point of view. Throughout the module, student participation in recognizing problems, seeking solutions, and improving conditions is necessary. The approach should emphasize problem solving rather than mere information dissemination.

The Healthy Worker. Students are asked to identify ways of demonstrating normal and/or abnormal functioning of their body as a way of monitoring their health status. By exploring basic assessment techniques used by health professionals to monitor the health of the human body, students will be able to monitor their personal health status.

The Safe Worker. This topic seeks to identify health and safety concerns related to specific occupations. Students will develop techniques for recognizing unsafe job-related situations and will become acquainted with safety standards and practices appropriate for specific occupations.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Describe the normal functioning of human body systems
2. Describe symptoms of abnormal functioning of human body systems
3. Explain the need for basic health assessment techniques to monitor the status of human body systems

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY

4. Determine kinds of basic health assessment techniques utilized to monitor the status of human body systems
5. Describe basic health assessment techniques used to monitor the status of human body systems
6. Determine the significance of basic health assessment technique results
7. Apply the results of basic health assessment techniques to maintenance of good health
8. Relate maintenance of sound health practices to life and job productivity
9. Identify specific examples of health and safety problems in occupational areas
10. Determine possible effects of health and safety hazards on the human body
11. List possible ways of monitoring the level of health and safety hazards
12. Determine a health and safety standard for each occupational hazard
13. Develop control techniques to minimize the danger of the health and safety hazards
14. Identify and demonstrate the type of safety equipment that is appropriate for handling specific kinds of materials
15. Describe ways of avoiding worker positions that may lead to accidents on the job
16. Describe ways of avoiding worker actions that may result in accidents
17. Describe how tools and equipment use can be modified to protect the worker
18. Identify safety rules to minimize the danger of health and safety hazards
19. Develop emergency procedures to deal with occupational conditions that become unsafe

ESTIMATED MINIMUM TEACHING TIME: 27 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY

CONTENT OF THE MODULE

- * I. The Healthy Worker
 - * A. Normal functioning of body systems
 - *1. Circulatory
 - *2. Respiratory
 - 3. Digestive
 - 4. Excretory
 - 5. Nervous
 - 6. Endocrine
 - 7. Muscular
 - 8. Skeletal
 - 9. Reproductive
 - 10. Immune
 - 11. Integumentary
 - * B. Abnormal functioning of body systems
 - * C. Need for basic health assessment techniques
 - * D. Basic health assessment techniques
 - *1. General survey
 - *a. Signs of distress
 - *b. Dress, grooming, personal hygiene
 - *c. Manner, mood, and relationship to persons and things in the environment
 - d. Posture and gait
 - e. Odors
 - f. Facial expression
 - g. Speech
 - *2. Circulatory system
 - *a. Blood pressure
 - b. Blood test
 - c. EKG
 - d. Stress test
 - e. Pulse rate
 - *3. Respiratory system
 - *a. Vital capacity
 - b. TB (Tyne and Mantoux)
 - c. Throat culture
 - d. X-ray
 - e. Metabolic rate
 - f. Sputum
 - 4. Digestive system
 - a. Weight
 - b. Stool specimen
 - c. Diet history

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY

CONTENT OF THE MODULE, continued

5. Excretory system
 - a. Urine
 - b. Stool specimen (Guaiac)
6. Nervous System
 - a. EEG
 - b. Hearing
 - c. Vision
 - d. Reflex
 - e. Sensitivity
 - f. Balance
 - g. Intelligence
 - h. Psychological-psychomotor
 - i. State of awareness
 - j. Coordination
7. Endocrine System
 - a. Blood test
 - b. Urine test
 - c. Metabolic rate
8. Muscular System
 - a. Strength
 - b. Endurance
9. Skeletal System
 - a. X-ray
 - b. Scoliosis screening
 - c. Range of motion
10. Reproductive System
 - a. Pregnancy
 - b. Pap smear
 - c. Sperm count
11. Immune System
 - a. Sensitivity (allergic)
 - b. Temperature
 - c. Immunizations
12. Integumentary System
 - a. Skin color
 - b. Vascularity
 - c. Lesions and blemishes
 - d. Edema
 - e. Temperature
 - f. Integrity
 - g. Hair analysis
 - h. Scalp examination
 - i. Nail examination
- *E. Basic health assessment technique results
- *F. Maintenance of good health
- *G. Relationship of sound health to life and job productivity

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY

CONTENT OF THE MODULE, continued

- * II. The Safe Worker
 - * A. Categories of health and safety hazards
 - * 1. Chemical hazards
 - * a. Fibers
 - * b. Liquids
 - * c. Gases
 - * d. Vapors
 - * 2. Physical hazards
 - * a. Noise
 - * b. Vibration
 - * c. Radiation
 - * d. Lighting
 - * e. Ventilation
 - * f. Space
 - * g. Environment
 - * h. Motion
 - * i. Electricity
 - * j. Temperature
 - * k. Height
 - * l. Surface condition
 - * m. Climate
 - * 3. Personal health hazards
 - * a. Drugs
 - 1. Alcohol
 - 2. Tobacco
 - * b. Stress
 - * c. Fatigue
 - * d. Infection
 - * e. Lack of sanitation
 - * B. Effects of health and safety hazards on the body
 - * C. Monitoring health and safety hazards
 - * D. Standards for health and safety hazards
 - * E. Control techniques for health and safety hazards
 - * F. Personal protective equipment (for)
 - * 1. Eyes and face
 - * 2. Ears
 - * 3. Head
 - * 4. Hands and arms
 - * 5. Feet and legs
 - * 6. Respiratory system
 - * 7. Trunk
 - * G. Situations affected by body stance and position
 - * 1. Striking against something
 - * 2. Being struck by something
 - * 3. Being caught between objects
 - * 4. Falling

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY

CONTENT OF THE MODULE, continued

- 5. Exposure to temperature extremes
- 6. Contact with electric current
- 7. Inhaling
- 8. Absorbing
- 9. Swallowing
- 10. Overexertion
- * H. Actions of people
 - *1. Adjusting personal protective equipment
 - 2. Changing positions
 - 3. Rearranging things
 - 4. Stopping work
 - 5. Attaching grounds
 - 6. Using lockouts
 - 7. Attaching guards and shields
- * I. Tools and equipment
 - *1. Appropriate
 - 2. Abused
 - 3. Condition
- * J. Safety rules
 - *1. Adequate
 - *2. Understood
 - *3. Reviewed
- * K. Emergency procedures
 - *1. Reporting accidents
 - *2. For reducing hazards
 - 3. First aid
 - 4. CPR

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE HEALTHY WORKER

GOAL

Upon successful completion of this topic, the student will be able to demonstrate a basic understanding of the normal parameters within which a healthy body functions. The student should identify abnormal functioning of the human body and deal with that circumstance with a health professional.

DESCRIPTION

This topic emphasizes the normal and abnormal functioning of the human body. Students are made aware of the need for health assessments, how they are performed, what they show, and how to follow up on the findings. The human body is approached system by system through the examination of health assessment techniques used by professionals to monitor the health of body systems.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Describe the normal functioning of human body systems
2. Describe symptoms of abnormal functioning of human body systems
3. Explain the need for basic health assessment techniques to monitor the status of human body systems
4. Name and describe the basic health assessment techniques used to monitor the status of human body systems
5. Determine the significance of basic health assessment technique results
6. Apply the results of basic health assessment techniques to maintenance of good health
7. Relate maintenance of sound health practices to life and job productivity

ESTIMATED MINIMUM TEACHING TIME: 15 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE HEALTHY WORKER

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will describe the normal functioning of each human body system.

In order to do this, the student must be able to:

- a. List the major systems of the human body
- b. Describe the normal basic functions of each human body system listed

2. Following appropriate instruction, the student will describe several basic symptoms of abnormal functioning of human body systems.

In order to do this, the student must be able to:

- a. Differentiate between abnormal and normal functioning of each body system
- b. List several possible abnormal symptoms of each human body system

3. Following appropriate instruction, the student will explain the need for basic health assessment techniques to monitor the status of human body systems.

In order to do this, the student must be able to:

- a. Define basic health assessment techniques
- b. Describe the need for basic health assessment techniques

4. Following appropriate instruction, the student will name and describe the kinds of basic health assessment techniques used to monitor the status of human body systems.

In order to do this, the student must be able to:

- a. List the most generally used methods to monitor the health status of human body systems
- b. Indicate which of these methods are most commonly used to monitor the health status of human body systems
- c. Describe the preparations necessary for the patient to have these health assessments performed
- d. Describe the necessary steps involved to administer these health assessment techniques

5. Following appropriate instruction, the student will identify normal parameters of assessment technique results.

In order to do this, the student must be able to:

- a. List the normal parameters of assessment technique results
- b. Determine where his or her results might fall in terms of normal parameters

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE HEALTHY WORKER

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES, continued

6. Following appropriate instruction, the student will apply the results of health assessment techniques for maintenance of good health.

In order to do this, the student must be able to:

- a. Explain the significance of health assessment technique results
- b. List possible courses of action an individual might take to deal with those results
- c. Indicate an appropriate level of treatment for the results obtained
- d. Indicate how to monitor the level of success of the treatment plan

7. Following appropriate instruction, the student will relate maintenance of sound health practices to life and job productivity.

In order to do this, the student must be able to:

- a. List sound health practices that should be maintained
- b. List ways in which one's life and job productivity can be influenced by sound health practices

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE HEALTHY WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Have students list the basic functions necessary for an organism to maintain life (e.g., heart action, breathing, digestion).
- b. Have students list the human body systems they associate with the functions necessary to maintain life (e.g., heart action, breathing, digestion).
- c. Have students describe the kind of body parts necessary to perform the required life functions, without naming or describing particular organs (e.g., a long tube that could absorb digested food materials into a distribution system, tubes by which digested food materials can enter and leave the body, thin sacs through which gas can be exchanged, a filter that removes undesirable materials from the body).
- d. Have students list familiar organs of the human body and relate each organ to a particular body system and function (e.g., small intestine - digestion; capillaries - circulation; lungs - respiration; kidneys - excretion). Discuss integrated body functions.

2. (P. O. #2)

- a. From their own experiences, have students describe what they consider to be abnormal functioning of each of the human body systems (e.g., an ulcer, high blood pressure, bronchitis, diarrhea).
- b. Have students clarify criteria for determining whether a certain body function is abnormal or not, and the variables such as age, sex, weight, or illnesses, that one must consider (e.g., normal blood pressure range, white blood cell count, pulse rate, blood sugar analysis).
- c. Have students discuss why such criteria are necessary, the importance of standards of normalcy for assessing the health of the human body, as well as for such other things as money, measurements, electricity, gasoline, and health products (e.g., standard units of currency within a country; standard size film within the photographic industry; standard size threads on nuts and bolts; standard units for recording blood pressure).
- d. Have students bring to class newspaper articles pertaining to human medical problems, such as cancer, organ transplants, and AIDS, for the purpose of classroom discussion (e.g., career risk among agricultural workers; AIDS risk to blood recipients; carbon monoxide poisoning risk to auto shop workers; food poisoning caused by food service workers).
- e. Have students list the basic food nutrients, their body functions, possible sources, and recommended daily allowances (e.g., chart the foods eaten in a day and the nutrients they contain; perform simple chemical tests for sugar and starch in sample foods).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE HEALTHY WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

- f. Have students determine their average daily calorie requirements. Make a simple calorimeter and determine the number of calories in different types of nuts. Record the number of calories in an average daily diet. Determine the number of calories used in various activities.
- g. Have students determine if they eat a balanced diet. List four basic food groups; list several examples of foods from those food groups.
- h. Have students describe circumstances that might require special dietary modification (e.g., high blood pressure - low-salt diet; overweight - low-calorie diet; diabetes - low-carbohydrate diet; high cholesterol - low-fat diet).
- i. List familiar diseases and have students identify which body organ and system is functionally abnormal. Discuss influence of variables such as body types, sex, age, and weight.

3. (P.O. #3)

Have students compile a list of the common health assessment techniques they are familiar with. If this list does not reach the desired level of completeness, have students refer to appropriate resource materials for further information they can share with the class (e.g., electrocardiogram, throat culture, scoliosis screening, hearing test). Discuss the assessment techniques from the health care consumer's perspective, not from the health care worker's perspective.

4. (P. O. #4)

Have students relate each health assessment technique to a particular human body system (e.g., electrocardiogram - circulatory; throat culture - respiratory; scoliosis - skeletal; hearing - nervous).

- a. Have students describe how the health assessment techniques are performed and any safety precautions that may be necessary. Resource materials may need to be made available (e.g., urine test - cleanliness; throat culture - contamination; x-ray - shielding; intelligence test - distraction).
- b. Have students describe special supplies or equipment required to carry out the health assessment techniques and how they are used. Resources should be available for student use (e.g., pulse rate - stethoscope; hearing - audiometer; blood test - syringe; blood pressure - sphygmomanometer).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE HEALTHY WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

4. (P. O. #4) continued

- c. Have students describe preparations an individual should make for having each health assessment performed (e.g., blood-sugar test - food intake restriction; gastro-intestinal x-ray - enema; urine test - first morning urination; mammogram - no caffeine).
- d. Have students describe the special skills and training required to carry out these assessment techniques. Relate to various health careers and possible resources in the career section of the school or guidance library (e.g., manual dexterity, cleanliness, accuracy, concern for patient comfort and privacy).
- e. Throughout these discussions, if appropriate, health professionals should be invited to visit the classroom and assist students in understanding health assessments (e.g., medical lab technician, R.N., M.D., x-ray technician).
- f. Arrange visits to health facilities (e.g., doctor's office, hospital lab, emergency room or HMO).
- g. Wherever possible, students should observe or actually perform as many of the health assessment techniques as possible (e.g., pulse rate, eye test, blood pressure, reflex test).

5. (P.O. #5)

- a. Have students obtain physical forms used in employment, medical lab testing sheets, or other health forms for discussion (e.g., a doctor's physical form, an employment physical form from a business or employment agency, a doctor's medical laboratory testing sheet).
- b. Have students analyze sample assessment results, if available, for parameters of normalcy (e.g., pulse rate, blood pressure, blood count, vision test, hearing test).
- c. Have students attempt to describe the implications of results that may fall outside the parameters of normalcy (e.g., low blood pressure in vehicle maintenance and repair; high blood pressure in precision metal work; high white blood count in food service; 20/200 vision in a draftsman).

6. (P. O. #6)

- a. Have students describe how they would react to various levels of abnormalcy and what measures they would consider advisable (e.g., hearing loss of a cosmetologist; poor balance of a construction worker; color blindness of a graphics worker; farmer's lung disease of an agriculture worker; stuttering of a marketing worker).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE HEALTHY WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

6. (P. O. #6) continued

- b. Have students describe how they would continue to monitor a health problem during and following treatment (e.g., seizures of an electrical worker; diabetes of a home economist; diarrhea of a health occupation worker; migraine headaches of a technologist).
- c. Have students describe how they would determine when treatment is no longer necessary (e.g., flu in a cosmetologist; physical therapy in a precision metal worker who has had a hand injury; drug addiction of a health occupation worker; alcoholism of a building-maintenance worker).

7. (P. O. #7)

- a. Have students list ways in which job and life productivity can be influenced by personal health practices (e.g., smoking vs. non-smoking; use of alcohol vs. non-use of alcohol; rest vs. exhaustion; cleanliness vs. poor hygiene).
- b. Have students describe what they consider necessary health practices of maintaining productivity on-the-job and in life (e.g., adequate rest for a construction worker; good posture for a technologist; good personal hygiene for a businessman; good grooming for a cosmetologist).
- c. Have students describe what they consider health practices that detract from productivity on the job and in life (e.g., smoking, alcohol and drug abuse, poor personal hygiene, poor grooming, ignoring need for health care, denying a psychological problem, not coping with stress).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

GOAL

Upon successful completion of this topic, the student will be able to differentiate between safe and unsafe, healthy and unhealthy, working conditions. Students will explain the need for appropriate rules, standards, and protective equipment to deal with safety conditions related to their occupation. Accidents still do occur, and the student will develop ways to deal with emergencies.

DESCRIPTION

This topic emphasizes the need for safety and health consciousness on the job. Students are made aware of unsafe and unhealthy working conditions related to occupations. They are expected to describe monitoring devices, standards, control techniques, protective equipment, and appropriate rules necessary to help a worker cope with undesirable conditions. Ways to avoid common human errors that result in accidents are explored, along with emergency procedures for dealing with accidents that result from unsafe or unhealthy conditions.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Identify specific examples of health and safety problems by occupational areas
2. Determine the possible effects of the listed health and safety hazards on the human body
3. List possible ways of monitoring the level of health and safety hazards involved in the listed problems
4. Determine a health or safety standard for each occupational hazard listed
5. Develop control techniques to minimize the danger of the health or safety hazard
6. Identify and demonstrate the type of safety equipment that is appropriate for handling specific kinds of materials they may encounter in their occupational area
7. Describe ways of avoiding worker positions related to their occupation that may lead to accidents on the job
8. Describe ways of avoiding worker actions that may lead to accidents
9. Describe how tool and equipment use can be modified to protect the worker
10. Identify safety rules to minimize the danger of health and safety hazards
11. Develop emergency procedures to deal with occupational conditions that become unsafe

ESTIMATED MINIMUM TEACHING TIME: 12 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will list specific examples of occupational health and safety problems in several career areas.

In order to do this, the student must be able to:

- a. List several categories of occupations
- b. Determine specific health problems associated with each career area
- c. List categories of chemical, physical, or personal hazards related to work

2. Following appropriate instruction, the student will identify the possible effects of health and safety hazards on the human body.

In order to do this, the student must be able to:

- a. Relate health and safety problems to the functioning of human body systems
- b. Describe the type and degree of damage health and safety problems have on human body systems

3. Following appropriate instruction, the student will discuss possible ways of monitoring the level of health and safety hazards related to occupational health and safety problems.

In order to do this, the student must be able to:

- a. List several methods of monitoring health and safety problems in the work environment
- b. Describe why the level of a health and safety hazard needs to be monitored

4. Following appropriate instruction, the student will identify a safe health or safety standard for occupational hazards.

In order to do this, the student must be able to:

- a. Identify what minimum short-term levels of exposure to a health or safety hazard would result in possible damage to the human body
- b. Identify what minimum long-term levels of exposure to a health or safety hazard would result in possible damage to the human body

5. Following appropriate instruction, the student will explain how control techniques can be developed to minimize the danger of health or safety hazards.

In order to do this, the student must be able to:

- a. Describe what health or safety hazard needs to be controlled
- b. Determine if the level of the health or safety hazard can be controlled
- c. Explain how the level of the health or safety hazard can be controlled in the workplace

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES, continued

6. Following appropriate instruction, the student will identify and describe the kind of safety equipment that is appropriate for handling specific kinds of job-related materials and explain how it is used.

In order to do this, the student must be able to:

- a. List the parts of the body that need safety equipment protection
- b. List several possible pieces of safety equipment that could offer protection to those parts of the body
- c. Explain the different significant capabilities of various pieces of safety equipment
- d. Decide which piece of equipment is most appropriate for the degree of safety and health hazard associated with a job
- e. Explain how to most effectively use appropriate safety equipment
- f. Explain how safety equipment should be stored and maintained in order to keep it in usable condition
- g. Explain how safety equipment can be tested
- h. Describe the standards of performance that must be maintained for safety equipment
- i. Explain how faulty safety equipment can be reconditioned

7. Following appropriate instruction, the student will describe ways of avoiding worker positions that may lead to accidents on the job.

In order to do this, the student must be able to:

- a. Define what is meant by worker positions
- b. Describe examples of worker positions that may result in accidents on the job
- c. Describe factors that make those worker positions hazardous
- d. Explain how those factors that make worker positions hazardous can be minimized

8. Following appropriate instruction, the student will describe ways of avoiding worker actions that may lead to accidents on the job.

In order to do this, the student must be able to:

- a. Describe what is meant by worker actions that may be hazardous
- b. Cite examples of worker actions that lead to accidents on the job
- c. Describe factors that make those worker actions hazardous
- d. Explain how those factors that make worker actions hazardous can be minimized

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES, continued

9. Following appropriate instruction, the student will describe how tools and equipment use can be modified to protect the worker.

In order to do this, the student must be able to:

- a. Describe the kinds of safety hazards that are associated with certain kinds of tools and equipment
- b. Describe the kinds of safety hazards that are associated with the way tools are used or abused
- c. Describe the kinds of safety hazards that are associated with the way tools and equipment are maintained
- d. Explain how tools and equipment can be modified to minimize accidents
- e. Explain how the use of tools and equipment can be regulated to minimize accidents
- f. Explain how tools and equipment maintenance can be modified to minimize accidents

10. Following appropriate instruction, the student will develop safety rules to minimize health and safety hazards.

In order to do this, the student must be able to:

- a. Identify specific safety and health hazards that exist on a job
- b. List ways of controlling the safety and health hazards that exist on a job
- c. Develop rules necessary to maintain healthy and safe conditions on a job

11. Following appropriate instruction, the student will describe what procedures would be necessary in a workplace if an emergency arises.

In order to do this, the student must be able to:

- a. Describe emergency situations that could develop and require a company policy regarding appropriate procedures
- b. Identify possible emergency procedures that could be used to deal with the situation
- c. Describe the best possible emergency procedures for specific situations
- d. Describe government's role in maintaining health and safety standards in the workplace
- e. Describe the role of labor unions in maintaining health and safety standards in the workplace

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Have students list daily activities at work and outside of work in two columns. Using risk factor information, have students assign a risk factor to each of these activities. Compare the level of risks they would encounter in their outside-of-work time to the risks while in the work place. Discussion of results should illustrate to students that the personal activities they pursue may have a higher risk factor than those activities required of them as employees (e.g., risk factors for a carpenter on the job compared to a person painting his own house; risk factors involved in mowing a lawn compared to those of a drill press operator; risk of falls at home compared to risk in industry; risk of eye injuries at home compared to risk as a vehicle maintenance worker).
- b. Provide students information on the Occupational Safety and Health Administration (OSHA) regulations relating to asbestos and fiberglass use. Have students list where these materials are commonly used and by what types of workers (e.g., fiberglass insulation is used in construction; asbestos is encountered in building maintenance; asbestos for fire-proofing is involved in industrial safety).
- c. Conduct lab demonstrations using common solvents and substances used in industrial and home cleaners, such as lye, chlorine, ammonia, and mercuric acid. Possible activities might include:
 1. Reading instructions and warnings on labels.
 2. Creating a variety of dirty surfaces.
 3. Cleaning surfaces as directed.
 4. Discussing why results vary.
 5. Relating frequency of use to toxicity level and synergism.
 6. Discussing chemical implications of mixing various cleaners (e.g., possible dangers of using toilet bowl cleaner containing hydrochloric acid with a sodium hydroxide-type drain cleaner; reading warnings printed on agricultural chemicals; health hazards associated with a mercury spill in a health occupation).
- d. Have students list positive and negative radiation uses. Discuss different types of radiation exposure relative to quantity and quality and length of exposure. Information should include ultrasound, microwave, nuclear and X-ray radiation. (e.g. How can microwave oven use be potentially hazardous? How has ultrasound use been important to medical diagnosis? How much nuclear or X-ray radiation is too much?)
- e. Have students test several objects for presence of microbes using microbiological agar plates. Hair, unwashed skin, washed skin, etc. make good sources of study. Be sure to keep one unexposed as a control. Exposing one just to air is also useful (e.g., important in preventing spread of disease among cosmetology, child care, and health and food service workers).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

1. (P. O. #1) continued

- f. Discuss the need for cleanliness and good sanitation. Discuss how infections can be spread in the workplace and preventative measures that should be taken (e.g., proper washing of hands after bathroom use; use of facial mask in isolation cases; use of hair nets in food service; use of rubber gloves in health occupations or food service).
- g. Have students visit a workplace and determine what health and safety hazards exist there. (e.g., construction site, local factory, local hair dressers, auto repair shop, agribusiness).
- h. Have guest speakers from several different kinds of workplaces describe the health and safety hazards that exist there and how they are dealt with (e.g., safety coordinator from a local industry; local fire safety inspector; building and grounds director for a local school district).
- i. Have students list physical and chemical hazards found in the workplace by consulting OSHA, safety and health manuals, or various resource people (e.g., carbon monoxide in a vehicle repair area; electrical shock in electronics; chemical burns in cosmetology; gasoline vapors in vehicle maintenance).

2. (P. O. #2)

- a. Research the physical problems experienced by workers using asbestos as well as those who work in an environment where that material has been used. Determine, if possible, the risk factor and the reduction of risk when protective clothing and gear are worn (e.g., risk of asbestos contamination in a building maintenance worker removing asbestos while wearing various types of face masks).
- b. Have students research byssinosis. Relate findings to employees of textile factories where cotton is processed. Discuss protective devices which may be required for jobs in the textile industry. Also discuss the geographic location of the factories and the types of products they produce. (e.g., What is the risk of byssinosis among fashion designers, fabric buyers, clothing industry workers? Is protective gear warranted?)
- c. Create case studies (hypothetical or real) of jobs where vinyl chloride, carbon monoxide, hydrogen cyanide, formaldehyde, and Radon gas are a hazard. Have students determine the job hazards, what regulations and safety practices apply to these jobs, and what possible medical problems can result from working at these jobs (e.g., carbon monoxide hazard in vehicle maintenance and repair; carbon tetrachloride use as solvent in dry cleaning; formaldehyde hazard in insulation materials; nitrous oxide silo gas).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

- d. Bring in an assortment of lights and bulbs (including strobe, fluorescent, incandescent, black light), and experiment reading various light levels with a light meter. Students can record visibility levels and comfort levels utilizing the lights in a variety of ways and angles. Use colored bulbs with the same experiments. Record effects and relate to jobs where different types of lighting may be needed. Topics for discussion should include vision quality and eye protection (e.g., judging fabric colors under fluorescent, colored, or incandescent lighting; color of chalkboard and chalk, and related eye fatigue; amount of light necessary for eye comfort in reading detailed drawings, blueprints, or graphics).
- e. Bring three or four computers with video display terminals into the classroom. Experiment with natural and artificial lights of varying intensity to determine worker comfort. Relate this to eye fatigue and worker productivity. Have students research the relationship of video terminal use and eye fatigue (e.g., color of screen and lettering related to eye strain and fatigue; reading a book by fluorescent and incandescent lighting of varying intensities; need for windows in a place of business vs. windowless work area).
- f. Experiment with the classroom climate by increasing and decreasing the humidity, temperature, and air movement. Assign students a 15-minute period of vigorous physical movement followed by 15 minutes of desk work. Change the temperature and humidity of the room after each type of activity. Have students record the relative comfort levels they experience on a scale of 1-10 during each set. Discuss physical comfort, energy level, and emotional reactions, in terms of importance to the worker, worker performance, and the industrial hygiene of the work place. Develop objective rather than subjective means of evaluating the effects of humidity, temperature, and ventilation on work performance, attention span, time on task, distractability, and accuracy.
- g. Have students view a film depicting a person driving a car who has consumed drugs and/or alcohol. Relate observations to workers under the influence of chemicals on the job. Discuss safety factors in relation to the worker and to other workers, as well as to the quality of work performed. Draft your own description of a hangover, being on drugs, or a hypochondriac on the job, and a possible management response to the situation.
- h. Have students write anonymous descriptions of a "hangover" (or how a person appears to feel). Ask students to assume the role of supervisor. Read a selection of the descriptions and ask the "supervisor" to write responses to this worker being on the job. Change the problem worker's sex and age to determine if this information has any effect on the "supervisor's" response. Poll responses of employers and other adults and compare to student responses. Acquire actual case histories, if possible, from local personnel offices. Delete names to avoid invasion of privacy.

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

- i. Create several hypothetical case studies of workers of various ages and sex who use chemical substances heavily off the job, on the job, who live with someone who is addicted, or is a recovering substance abuser (e.g., antihistamines, cough depressants, muscle relaxants, sleeping pills, or stimulants such as caffeine pills or nicotine gum). Ask students to respond to the following questions for each case study:

Will this person have problems on the job today? What specific problems do you anticipate? Since you share the responsibility of a machine function with this person, what are your concerns for this worker? What are your concerns for yourself? What should the supervisor do about this situation? What should you do about this situation? If you were a member of this person's immediate family (brother, sister, wife, husband, child) what would you do? Does the company have a right or responsibility to become involved?

- j. Have students bring in labels from various commonly used medications and discuss possible effects or side effects upon the worker.

3. (P. O. #3)

- a. Discuss gases that have an odor as a warning property, such as natural gas, propane, butane, and bromine. Display symbols that are used to warn about the properties of gases. Discuss what additives are added and why they were put there; also, why this means of protection may not always work. Discuss the problem of detecting the presence of an odorless gas, such as carbon monoxide, and the possible hazards and use of sulfur in natural gas to give it a detectable odor.
- b. Have students describe a worker on the job in the occupation of their choice. They should point out each behavior by the worker that may have contributed, minimized, or prevented disease transmission. Discuss each worker (e.g., sterile technique in handling a patient's sterile dressing; sterilizing jars while canning of foods; cleaning combs between uses in a beauty salon.)
- c. Have students visit workplaces in order to determine how the levels of health and safety hazards are monitored. (Is there a health or safety inspector? How often does he/she inspect? What does he/she look for? What is done about violations in the place of business, a factory or office, in the home, or on the farm?)
- d. Have health and safety personnel from a work environment explain and/or demonstrate how they monitor health and safety hazards on the job (e.g., inspection check lists, monitoring devices, criteria levels).
- e. Wherever possible, have students experiment with the process of monitoring a health or safety hazard (e.g., use of an air-pollution detection chart in building maintenance; a radiation exposure tag in a power plant; a voltmeter or ammeter for an electrician).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

6. (P. O. #6) continued

- d. Invite a retailer or wholesaler of protective clothing and devices to demonstrate these items for students and explain reasons behind the design of each item. Consideration should be given to footwear, headgear, eye protection, ear protection, gloves of various types, respiration protection, face protectors, and protective suits.

Invite local fire department representatives to show their protective gear and explain why it is used. Also, have students brainstorm other jobs where protective gear is required (e.g., Construction - hardhat; when cleaning metal castings with air pressure - safety goggles; when handling toxic chemicals - face mask; when cleaning an oven with caustic chemicals - rubber gloves).

- e. Have students research the area of employment they think they may want to enter, determining any protective gear and ergonomic concerns relative to that job. Discuss safety as well as emotional factors regarding the gear, relating it to personal safety, product safety, and long-range medical implications for the worker (e.g., assembly line - height of work surface for good posture and relief of back strain; chair design and height for a cosmetologist to avoid having to bend over constantly; floor covering for a salesperson who must stand all day).
- f. Have students, as much as possible, experiment with the proper use of safety equipment, including fire extinguishers, gloves, headgear, face masks, ear plugs, goggles, and shoes (e.g., use of a fire extinguisher to put out an electrical fire in a home appliance; smothering a welder's clothing that is on fire with a fire blanket; use of safety goggles when working a metal lathe or drill press).
- g. Have the local fire department demonstrate the use of various pieces of safety equipment and fire extinguishers (e.g., when to use water, a dry chemical, or CO₂ extinguishers on fires in an auto body shop, appliance-repair shop, or drafting room).

7. (P. O. #7)

- a. Use a skeletal model or chart to help students become familiar with size, density of bones, and joint types. Relate skeletal parts to areas commonly injured (e.g., bending and pinched nerves in the back; dislocation of the shoulder joint from excessive lifting and reaching; ankle sprains from working on uneven surfaces).
- b. Have students demonstrate body positions that allow the body to work as an efficient tool and avoid injury (e.g., bending knees when lifting; getting close to your work to avoid excess reaching; using the large muscles and bones rather than smaller muscles and bones). Locate the center of gravity.

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P. O. #8) continued
 - g. Obtain literature from a stress management clinic. Share and discuss these materials with students, or have a guest speaker on this topic address the class.
 - h. Cite several examples of work-related accidents and ask students to analyze how worker action was related to the accident. Explore ways the accident could have been prevented (e.g., adjusting the face mask while welding; changing your body position while using a power saw; rearranging bottles of chemicals while shampooing someone's hair; walking away from a machine while it is still turned on).
9. (P. O. #9)
 - a. Cite several examples of work-related accidents and ask students to analyze how tools and equipment were related to the cause of the accident (e.g., dull drill bit; dull saw blade; cracked chemical container; cracked belt on a machine; oil leak in a compressor, poor or improper machine adjustment and/or maintenance). Explore ways the accidents could have been prevented.
 - b. Using several tools and items of equipment, have students demonstrate proper use, improper use, and safety features of each (e.g., proper use of a welding torch, grinding wheel, chemical sprayer, hair dryer, power saw).
10. (P. O. #10)
 - a. Have students participate in the development of safety and health rules for a shop in the school, a model business, or an actual business (e.g., use of fire escape; ventilation; exhaust of fumes; prevention of electrical shocks; and grease fires).
 - b. Have students analyze a comprehensive list of safety rules to identify the need for the rules and their effectiveness.
 - c. Have students investigate kinds of health and safety rules required in the occupational area they intend to pursue (e.g., union rules, management rules, OSHA requirements, insurance requirements, and fire codes).
 - d. Have students investigate how business establishes safety rules and maintains appropriate standards of conformance to those rules (e.g., inspectors, accident review boards, suggested employee procedure, accident report requirements).
 - e. Have students investigate the role of government and labor unions in maintaining health and safety standards in the workplace (e.g., trade unions; OSHA; FDA; county, state, and U.S. health departments).
 - f. Have students set up a hypothetical business. Have them then consider how health and safety are accounted for in the plans for the building, employees, raw materials, manufacturing, marketing, delivery, and consumers (e.g., fire escapes, storage areas, electrical grounding, smoke alarms, sprinkler systems, proper labeling, etc.).

OCCUPATIONALLY RELATED SCIENCE
MODULE: HEALTH SCIENCE AND SAFETY
TOPIC: THE SAFE WORKER

11. (P. O. #11)

- a. Have students survey area industries where the majority of the workers in the community are employed. Determine what types of health and safety services occur within these industries (e.g., first aid, medical treatment, fire protection, ambulance).
- b. Have students visit environmental health and safety facilities of a nearby industry or of a county or state health department. Prior to the visit, have the class list health and safety responsibilities they feel industry has to its workers, and obligations that workers have to the industry (e.g., exposure to radiation or chemicals; chemical pollution; noise; machine safety).
- c. Have students determine what kinds of emergency procedures are necessary in a workplace and how they are developed, practiced, and maintained (e.g., fire drills, first aid, calls for outside assistance, etc.). Who is in charge under various circumstances?
- d. Have students determine what kinds of emergency first aid is available in a workplace and how that service is developed, delivered, and maintained (e.g., first aid training available, trained personnel available, first aid equipment and facilities on hand).
- e. Have students use the DICTIONARY OF OCCUPATIONAL TITLES, the OCCUPATIONAL OUTLOOK HANDBOOK, and the THOMAS REGISTER to select a type of work they would be interested in exploring. Have them then write to the appropriate company to inquire about health services provided.

OCCUPATIONALLY RELATED SCIENCE MODULE: PHYSICS APPLICATIONS

OVERVIEW OF THE MODULE

GOAL

Upon successful completion of this module, the student will relate concepts of physical science to the working/living environment. The student will explore concepts about which they already possess introductory knowledge and relate these concepts to the working world and everyday experiences. Relating the scientific principles to the student's potential job environment should produce workers who are more interested and more effective on the job.

DESCRIPTION

The Physics Applications module is a nine-week (27-hour) segment of the Occupational Related Science Syllabus. The module is designed to introduce occupational students to concepts of physical science as they apply to various occupations in the working world. The module is divided into four topics that can vary in length and instructional time according to the identified needs of the student population. Each topic focuses on a particular area of physical science related to the workplace or life in the adult world. The teaching approach should emphasize problem solving rather than simply information delivery.

Mechanics. In this topic students are asked to interrelate forces, motion, energy, and work. Students apply their understanding to everyday experiences and the world of work.

Wave Motion and Energy Relationships. This topic presents students with properties of waves and relates them to light and sound. Students should understand how light and sound affect their environment.

Hydraulics and Pneumatics. This topic introduces the student to working situations where hydraulics and pneumatics are important.

Electricity and Magnetism. This topic introduces the student to concepts of electricity and magnetism and leads them to an understanding of the relationship between the two elements. Students apply their knowledge to practical situations.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Explain the meaning of force and how force is created
2. Distinguish speed from velocity and explain how force creates motion
3. Demonstrate an understanding of work and the ability to measure and calculate force, time objects in motion, measure distances, and use the work equation
4. Describe types and forms of energy, perform energy measurements using proper units, and describe the importance of conversions between energy forms

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS

5. Differentiate between transverse and longitudinal waves, diagram and label parts of a wave, indicate wave characteristics, and explain how energy is transmitted by waves
6. Discuss sound as a type of energy and relate this to energy levels, decibels, and pitch
7. Discuss light as a type of energy and relate this to the inverse square law, reflection, refraction, the electromagnetic spectrum, the photoelectric effect, and lasers
8. Define hydraulics and pneumatics
9. Demonstrate an understanding of the principles involved in hydraulics and pneumatics
10. Calculate static fluid pressure and mechanical advantage of hydraulic systems, and test for specific gravities of solids and liquids
11. Explain the two static charges, how they are established, and how they react to each other
12. Explain direct and alternating currents, draw circuit diagrams; wire series and parallel circuits; test the circuits, and see how they apply to the home
13. Explain North and South magnetic poles, magnetic fields, and how magnets are made
14. Discuss the relationship between electricity and magnetism and relate this to generators, transformers, and coils

ESTIMATED MINIMUM TEACHING TIME: 27 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS

CONTENT OF THE MODULE

- * I. Mechanics
 - * A. Force
 - *1. Definition
 - *2. Measurement of force
 - * B. Motion
 - *1. Relationship between force and motion
 - 2. Speed vs. velocity
 - 3. Newton's Laws of Motion
 - * C. Work
 - *1. Simple machines
 - *a. What machines do
 - *b. Types of machines
 - (1) Inclined plane
 - (2) Levers
 - (3) Wheel and axle
 - (4) Pulleys
 - *c. Mechanical advantage
 - *d. Efficiency
 - 2. Compound machines
 - 3. Definition and the work equation
 - 4. Work problems
 - * D. Energy
 - *1. Kinds
 - *a. Potential
 - *b. Kinetic
 - c. Conversion between potential and kinetic
 - *2. Forms/sources
 - *a. Mechanical
 - *b. Gravitational
 - *c. Chemical
 - *d. Heat
 - *e. Electrical
 - *f. Magnetic
 - *g. Nuclear
 - *h. Electromagnetic
 - 3. Measurement/units
 - 4. Conversions
- * II. Wave Motion and Energy Relationships
 - * A. The Nature of waves
 - *1. Types of waves
 - *a. Transverse waves
 - *b. Longitudinal

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS

CONTENT OF THE MODULE, continued

- *2. Characteristics of waves
 - *a. Wavelength
 - *b. Frequency
 - *c. Amplitude
 - *d. Speed
- 3. Parts of a wave
 - a. Crest
 - b. Trough
 - c. Nodes
- 4. Properties of waves
 - a. Reflection
 - b. Refraction
 - c. Propagation
 - d. Diffraction
 - e. Interference
- * B. Sound
 - *1. Sound in the environment
 - *2. Sound in occupations
 - 3. Longitudinal
 - 4. Echo
 - 5. Pitch
 - 6. Energy and decibels
 - 7. Resonance
 - 8. Interference
- * C. Light
 - *1. Transverse wave
 - *2. Sound vs. light
 - *3. Sources of light
 - *4. Instruments for the measurement of light intensity
 - 5. Illumination and the inverse square law
 - 6. Law of reflection
 - 7. Law of refraction
 - 8. Lenses
 - 9. The electromagnetic spectrum
 - 10. Color
 - 11. Wave-particle theory of light
 - 12. Laser light
- * III. Hydraulics and Pneumatics
 - * A. Definitions

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS

CONTENT OF THE MODULE, continued

- * B. Principles
 - *1. Mechanical advantage
 - 2. Bernoulli's Principle
 - 3. Specific gravity
 - a. Definition
 - b. Test for solids
 - c. Test for liquids
 - * C. Applications
 - *1. Movement of fluids, levers, and motion
 - 2. The hydraulic jack/brake systems
 - a. Static fluid pressure
 - b. Mechanical advantages
 - 3. Aircraft wing designs
 - 4. Test in industry
- * IV. Energy in Electricity and Magnetism
- * A. Static electricity
 - *1. Definitions - the two electric charges
 - *2. Insulators and conductors
 - 3. How charges are established
 - 4. Forces of attraction and repulsion
 - 5. Using the electroscope
 - 6. Testing the electric field
 - 7. Lightning
 - * B. Electric currents
 - *1. Definitions
 - a. Direct current
 - b. Alternating current
 - *2. Appliances change electrical energy to other forms of energy
 - 3. Symbols used in circuit diagrams
 - 4. The series circuit
 - 5. Volts and voltmeters
 - 6. Amperes and ammeters
 - 7. Ohms and ohmmeters
 - 8. Ohms law
 - 9. Parallel circuits
 - 10. Circuits in the home
 - * C. Magnetism
 - *1. The magnetic poles and forces
 - 2. The magnetic field
 - 3. What happens as a metal magnetizes
 - 4. How to make and destroy a magnet
 - 5. Temporary and permanent magnets

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS

CONTENT OF THE MODULE, continued

- * D. Applications of magnetism and electricity
 - * 1. Electric generators
 - * 2. Electromagnetism
 - 3. Transformers
 - 4. Induction coils

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: MECHANICS

GOAL

Upon successful completion of the topic Mechanics, the student will understand the interaction of force and motion and how it pertains to work. The student will also demonstrate an understanding of the importance of friction and how machines interact throughout the scheme of the work world.

DESCRIPTION

The topic introduces force and motion and how Newton's Laws of Motion help us understand what occurs. It also explores the concept of work (and energy) and how humans accomplish work and use machines to aid them.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Explain what a force is and how force is created
2. Distinguish speed from velocity and explain how force creates motion
3. Demonstrate an understanding of work and the ability to measure and calculate force, time objects in motion, measure distances, and use the work equation
4. Describe types and forms of energy, perform energy measurements using proper units, and describe the importance of conversions between energy forms

ESTIMATED MINIMUM TEACHING TIME: 11 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: MECHANICS

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will explain what force is and ways in which force is created.

In order to do this, the student must be able to:

- a. Define and understand the term "force"
- b. List types of force and their sources

2. Following appropriate instruction, the student will demonstrate the ability to time the movement of objects, explain how force brings about motion, measure the distances objects travel, and calculate average speeds at which objects travel.

In order to do this, the student must be able to:

- a. Use a stop watch
- b. Use metric and/or English rulers
- c. Measure the amount of force needed to make an object move
- d. Assimilate written or lecture information on Newton's Laws of Motion
- e. Define speed and velocity
- f. Explain, using Newton's Laws of Motion, how force creates motion
- g. Solve problems using the distance equation
- h. Solve equations with one unknown

3. Following appropriate instruction, the student will explain what work is, solve work problems, and develop an understanding of the part machines play in work.

In order to do this, the student must be able to:

- a. Assimilate written and lecture information on work and machines
- b. Solve simple equations with one unknown
- c. Distinguish between work, energy, power, and torque
- d. Recognize simple machines
- e. Identify simple machines within compound machines
- f. Gather and record data from laboratory activities
- g. Use data to calculate work, mechanical advantage, and efficiency

4. Following appropriate instruction, the student will list types and forms of energy, perform energy measurements using proper units, and describe the importance of energy conversions.

In order to do this, the student must be able to:

- a. Define and describe examples of kinetic and potential energy
- b. List forms and sources of energy
- c. Measure energy quantities and compare the units of various forms
- d. List examples of conversion between each set of energy forms and describe the importance of each example

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: MECHANICS

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Use appropriate reading and class discussion to introduce basic concepts of force (e.g., jack to lift up a car; a bulldozer to move soil; push or pull to open or close a classroom door; push or pull to open or close a window; push when one does "push-ups"; pull when one does "pull-ups").
- b. Have students experience force due to gravity, magnetism, static charges, and the push and pull with objectives and each other (e.g., Cosmetology: static electricity in hair, removing snarl from hair; Agriculture: force required when an implement gets stuck in wet ground; Home Economics: kneading dough or chopping food; Construction and Building Maintenance: locating studs in finished wall by magnetic attraction to iron nails).
- c. Use discussion and common experiences to develop the concept that all forces involve either a push or pull (e.g., Vehicle Maintenance and Repair: hydraulic lift to raise vehicles; Cosmetology: scissors; Food Services: pounding meat to tenderize it, or use of feeding arm on meat slicer).

2. (P. O. #2)

- a. Use appropriate reading and class discussion to introduce basic concepts of speed vs. velocity and Newton's Laws of Motion. (A stopped car is in park on an inclined plane, with the emergency brake on. The brake is released and the car put in neutral, it will respond to gravity and move. If the engine is started and the transmission shifted into gear, velocity is attained due to force from the engine.)
- b. Use discussion and common experience to develop the concept that a force creates motion (e.g., Construction and Building Maintenance: force on a hammer pounds in a nail, hammer can be used as a lever to remove nails; Food Services: dessert carts on wheels are commonly pushed to customers' tables; Health Occupations: patients are pushed or pulled on wheeled stretchers or chairs to move them easily from one location to another).
- c. In a laboratory activity, measure the amount of force needed to make an object move. (Attach a spring scale to an object and pull it across a table top at constant speed. Note what happens when motion first starts.)
- d. Use blocks of various masses to develop the relationship between mass and force in creating motion. (Continue the activity from "c" by adding weights on top of the block being moved. Business/Marketing: limit to weight of a load put on carts in warehouse.)
- e. Use the same equipment as in "d", but vary the surface under the block to change the amount of friction and, therefore, the force necessary to create motion.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: MECHANICS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

- f. Have students time objects exhibiting different types of motion, steady and accelerated. (Tie a string to a toy, with just enough weight on the string so the toy moves when the weight falls from the end of a table. Time how long it takes. Add additional weights and the car will accelerate. Determine the new time interval.)
- g. Introduce the distance equation ($d=rt$) and solve for average velocity. Discuss what happens when acceleration occurs. (Use timed data from "f" to show students how to resolve $d = rt$, to $r = d/t$, and substitute data gathered to find average velocity.)
- h. Conduct demonstrations of inertia and discuss the outcomes. (Place a coin on a piece of paper on a table top, with edge of paper beyond edge of table. Pull paper slowly and the coin will move with it. Pull paper fast and paper comes out from under coin. Slap paper with wet fingertips and paper comes out, but the coin barely moves at all. Stand flat-ended pen or pencil on paper, and paper can be "slapped" without tipping pen or pencil over.)

3. (P. O. #3)

- a. Use appropriate reading sources and discussion to develop the concept of work and the relationship of work to energy.
- b. Solve work problems using appropriate data for uncomplicated work situations. (e.g., Agriculture: lifting one ton of hay into storage area; Business/Marketing: unloading 50-pound bags of merchandise; Construction and Building Maintenance: lifting steel I-beams into place for new building; Cosmetology and Food Services: moving supplies into storeroom.)
- c. Conduct laboratory activities using inclined planes, pulley systems, and wheel and axle to gather data on force and distances. (e.g., Vehicle Maintenance and Repair: Study distance hand moves vs. how far engine is lifted using a chain hoist; Home Economics: Investigate how far fingers move vs. how far end of cooking tongs move.)
- d. Solve work problems using laboratory data.
- e. Solve efficiency problems using laboratory data.
- f. Solve mechanical advantage problems using laboratory data.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: MECHANICS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

3. (P. O. #3) continued

- g. Use discussion to list and identify examples of simple machines. (e.g., Agriculture: hayfork is a lever; Business/Marketing: ramps are inclined planes; Construction and Building Maintenance: elevators commonly use pulley systems; Cosmetology: lever arms on equipment to take stress away from operator; Drafting: lever arms on older, mechanical-drawing machines; Food Services: wheels used on service carts; Graphics Communication: use of wheels on wheelchairs, ramps instead of stairways; Home Economics: use of cooking tongs as levers; Vehicle Maintenance and Repair: a mechanical jack, hand pushes the end of the handle a long distance to lift car a short distance.)
- h. Using diagrams, models, and working machines, have students identify simple machines within more complex machines. (Many toys are working models of complex machines.)

4. (P. O. #4)

- a. Have students relate a bicycle ride up and down hills to potential and kinetic energy. Based on their mass and the height of the hill, have them approximate the distance they will roll up the other side of a hill after descending the first side.
- b. With parental permission, have students perform a simple home energy audit using the proper energy units. Have them compare their results to the capacity of their home heating source and with the bills that are paid for energy consumption.
- c. Have students list energy conversions within the school by describing the input and output forms of energy. Discuss the concepts of efficiency and entropy.
- d. Using a matrix, with the forms of energy as the rows and columns, have students fill in the blanks with an important energy conversion (e.g., solar energy into electricity run photovoltaic cells; solar energy into chemical energy via green plants; gasoline into movement via gas engines; chemical energy into kinetic energy via human body cells). Students may have to do some library research in order to complete the matrix.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: WAVE MOTION AND ENERGY RELATIONSHIPS

GOAL

Upon successful completion of this topic, the student should be able to demonstrate a knowledge of the nature of, and reason for, waves. The student will understand how certain types of energy can be transported using waves. The student will develop an understanding of light and sound and how they may affect environment and working space.

DESCRIPTION

This topic introduces the "wave" as one of nature's ways of transporting energy between two points. It refers to the two primary types of waves and relates them to light and sound. It investigates how humans utilize wave properties and characteristics to their benefit.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Differentiate between transverse and longitudinal waves, diagram and label parts of a wave, indicate wave characteristics, and explain how energy is transmitted by waves
2. Discuss sound as a type of energy and relate this to energy levels, decibels, and pitch
3. Discuss light as a type of energy and relate this to the inverse square law, reflection, refraction, the electromagnetic spectrum, the photoelectric effect, and lasers

ESTIMATED MINIMUM TEACHING TIME: 5 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: WAVE MOTION AND ENERGY RELATIONSHIPS

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following the appropriate instruction, the student will explain the relationship of longitudinal and transverse waves to energy transfer and define the parts, characteristics, and properties of waves.

In order to do this, the student must be able to:

- a. Define a wave
 - b. Differentiate between and give examples of longitudinal and transverse waves
 - c. Explain how waves change with changes in energy
 - d. Explain how energy can travel when the wave material does not
 - e. Label crests, troughs, and nodal points of a wave
 - f. Define and identify wavelength
 - g. Define frequency
 - h. Relate frequency and wavelength to wave speed
 - i. Define amplitude
 - j. State a meaning for each of the wave properties
2. Following the appropriate instruction, the student will explain sound energy, the characteristics of sound, and how sound affects the work and home environment.

In order to do this, the student must be able to:

- a. Define sound and relate it to longitudinal waves
 - b. Discuss sound waves with reference to frequency, pitch, amplitude, energy, wavelength, and wave speed
 - c. List the specific characteristics of sound waves and cite examples of each
 - d. Read and interpret information about sound and the effects of sound on individuals
3. Following the appropriate instruction, the student will explain light as energy and its relationship to the transverse wave; discuss the characteristics of light, the dual nature of light, and how each of these factors affect and are used in the student's environment.

In order to do this, the student must be able to:

- a. Define light and relate it to transverse waves
- b. Discuss sources of light energy
- c. Discuss how illumination occurs and how it is affected by the distance to the source
- d. Define reflection
- e. Define refraction
- f. Explain and discuss how lenses affect light
- g. Explain the electromagnetic spectrum and identify the position of visible light in it
- h. Discuss the relationship of frequency to color
- i. List examples of how the photoelectric effect is used
- j. List examples of how laser light is used

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: WAVE MOTION AND ENERGY RELATIONSHIPS

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Use appropriate readings and class discussions to explain relationships between basic wave concepts, wave parts, wave characteristics, and wave properties. (Water waves make excellent visuals to compare with less common waves. Students will relate to crest and trough and from this move to other terminology. Stress that the wave advances but the material does not. A discussion of what happens in "surfing" is helpful; the surfer rides the "surf", not a "wave".)
- b. Demonstrate waves using rope, springs, slinkies and/or wave tables. Vary the energy input and wave speeds. Discuss the observations. (Springs and slinkies allow the investigation of transverse vs. longitudinal waves, and the student can see the crests and troughs of the transverse wave as contrasted to the compressions and rarefactions of the longitudinal wave.)
- c. Construct and label wave diagrams.

2. (P. O. #2)

- a. Use appropriate reading sources and class discussion to bring out basic information about sound. (Sound is the most common type of longitudinal wave; loudness is due to energy level. Too much energy can cause pain and permanent damage to the system; therefore, safety equipment is essential.)
- b. Demonstrate variations in pitch, using a stringed instrument and containers of liquids. (Have a student bring a string instrument. Have the class study the effect of length, diameter, and tightness of a string (wire). Fill glasses with water to various levels and try to play "three blind mice" or a similar tune.)
- c. Demonstrate variations in sound intensity using a decibel meter.
- d. Demonstrate resonance, using a tuning fork and closed air columns. (This is best accomplished with a long, small diameter, glass tube that is sealed off at one end. Vibrate the tuning fork and add water to tube until resonance, noted by a considerable increase in loudness, is reached. Mark the tube with grease pencil and repeat using several other tuning forks. Discuss relationships between resonance, tube length, frequency, and wavelength.)
- e. Demonstrate interference by rotation of a vibrating tuning fork. (Hold vibrating fork close to ear and rotate slowly. Constructive and destructive interference will be noted as fork is rotated.)
- f. Invite a guest to discuss industries' concern with sound levels in work areas.
- g. Use class discussion to relate where students and/or their parents have encountered rules relating to hearing-protection gear.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: WAVE MOTION AND ENERGY RELATIONSHIPS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

3. (P. O. #3)

- a. Use appropriate readings and class discussions to bring out basic information about light. (Light is a transverse wave, in many ways similar to water waves. Travel through empty space is possible because it has its own photons. Colors of objects are colors reflected, the other wavelengths are absorbed. Observe various colors in red light, then in green, or blue light.)
- b. Conduct a laboratory activity whereby students measure arrival times for light and sound. (Go to a football field or other measured area and fire a starter's pistol; or hit a ball with a bat, or a post with a sledge hammer. Start stop-watches when you see puff of smoke (or contact with post), and stop the watch when sound arrives.)
- c. Starting with the sun as a primary source, discuss the nature of various sources of light.
- d. Demonstrate variation in illumination with variation in distance, using a light source and light meter (e.g., Agriculture: position of growth lamps to plants; Business/Marketing: proper illumination in office or storage areas; Construction and Building Maintenance: position of lighting fixtures in rooms with high ceilings; Cosmetology and Drafting: problems of proper illumination in work areas; Electrical/Electronics: problem of getting electricity to lights in show-rooms; Graphics Communications: sufficient lighting without glare.)
- e. Conduct laboratory activities on light reflection (e.g., Vehicle Maintenance and Repair: problem of glare reflection from polished surfaces; Technology: development of reflection techniques; Home Economics: colors and shades of colors in room lighting.)
- f. Conduct laboratory activities involving light refraction. (Check science laboratory manual for investigations.)
- g. Set up demonstrations to show the effect of lenses on light.
- h. Have students construct ray diagrams for reflection, refraction, and lenses.
- i. Carry out a laboratory activity, using a spectroscope and colored filters to study the colors of light.
- j. Use appropriate reading sources and discussion to develop the concept of the electromagnetic spectrum and the position of visible light in it.
- k. Invite a guest to discuss the concept and industrial uses of the photoelectric effect.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: WAVE MOTION AND ENERGY RELATIONSHIPS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

- l. Invite a guest to discuss the concept and uses of laser light and its importance. Lasers have many applications in the work world, especially in cutting and measuring (e.g., Construction and Building Maintenance: checking building under construction; Health Occupations: treatment of medical problems, for example, cataracts; Home Economics: cutting materials for clothing on a large scale; Precision Metal: cutting metals.)
- m. Demonstrate various ways to measure light and discuss devices used for the measurement of light intensity.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: HYDRAULICS AND PNEUMATICS

GOAL

Upon successful completion of this topic the student will have an understanding of the importance of hydraulics and pneumatics in a working environment as well as in daily life.

DESCRIPTION

The topic introduces the student to working situations where hydraulics and pneumatics are important. It also leads the student through mathematical calculations that develop the concepts.

SKILLS, KNOWLEDGE, AND BEHAVIOR TO BE DEVELOPED

The student will be able to:

1. Define hydraulics and pneumatics
2. Demonstrate an understanding of the principles involved
3. Calculate static fluid pressure, mechanical advantage of hydraulic and pneumatic systems, and test for specific gravities of solids and liquids

ESTIMATED MINIMUM TEACHING TIME: 2 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: HYDRAULICS AND PNEUMATICS

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will explain hydraulics and pneumatics and relate these to an occupational area.

In order to do this, the student must be able to:

- a. Define hydraulics
- b. Define pneumatics
- c. Cite one example of where each of the above is used in a declared occupational interest area or life environment

2. Following appropriate instruction, the student will explain Bernoulli's Principles and Pascal's Law, and measure specific gravity of solids and liquids.

In order to do this, the student must be able to:

- a. Use a hydrometer properly
- b. Read a hydrometer accurately
- c. Take measurements for and calculate specific gravity

3. Following appropriate instruction, the student will discuss practical applications in the work world, including calculations of static fluid pressure and mechanical advantage in hydraulic jacks.

In order to do this, the student must be able to:

- a. Discuss pressure relationships in systems
- b. Use a balance and overflow can
- c. Solve equations involving one unknown
- d. Apply Pascal's Principle to simple physical situations

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: HYDRAULICS AND PNEUMATICS

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

Use appropriate reading sources and class discussion to develop the basic concepts of hydraulics and pneumatics.

2. (P. O. #2)

- a. Demonstrate Bernoulli's Principle, using a piece of paper and a breath of air, or a hairdryer and a Ping-Pong ball.
- b. Use a hydrometer to measure alcohol content of a solution.
- c. Conduct a laboratory activity in taking measurements and calculating specific gravity of solids.

3. (P. O. #3)

- a. Use appropriate reading sources and class discussion to develop the basic concepts of fluid pressure.
- b. Demonstrate lifting capabilities of an hydraulic jack. Discuss how it works.
- c. Test a hydraulic jack and calculate its mechanical advantages.

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: ELECTRICITY AND MAGNETISM

GOAL

Upon successful completion of this topic, the student will understand that electricity and magnetism influence our lives in many ways, and have changed our lifestyles in work and leisure. The student will understand the importance of the development of electricity and magnetism.

DESCRIPTION

This topic introduces circuit diagrams and series and parallel circuits, also the testing of electrical current using appropriate meters. It explores the theories of magnetism and the magnetic-electric interrelationship.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Explain the two static charges, how they are established, and how they react to each other
2. Explain direct and alternating currents, draw circuit diagrams, wire series and parallel circuits, test the circuits, and see how they apply to the home
3. Explain North and South magnetic poles, magnetic fields, and how magnets are made
4. Discuss the relationship between electricity and magnetism, and relate this to generators, transformers, and coils

ESTIMATED MINIMUM TEACHING TIME: 9 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: ELECTRICITY AND MAGNETISM

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will discuss the nature and origin of static charges, demonstrate how to test charges, and relate static charges to lightning.

In order to do this, the student must be able to:

- a. Discuss what causes establishment of (+) and (-) charge
 - b. Explain the movement of charges between materials
 - c. Explain why charges build up on insulators
 - d. Demonstrate how to charge an electroscope and use it to test for charge
2. Following appropriate instruction, the student will read circuit diagrams, wire circuits, test circuits using appropriate meters, and apply Ohm's Law.

In order to do this, the student must be able to:

- a. Wire a simple circuit after deciphering a circuit diagram
 - b. Accurately use volt and ammeters
 - c. Solve equations with one unknown
3. Following appropriate instruction, the student will demonstrate a knowledge of magnets and magnetism and the forces and field of the magnet.

In order to do this, the student must be able to:

- a. Explain the concept of the magnetic domain
 - b. Explain ferromagnetic materials
 - c. Use a magnetic compass
4. Following appropriate instruction, the student will explain the relationship between electricity and magnetism, and how this is applied in our everyday lives and work.

In order to do this, the student must be able to:

- a. Explain electromagnetism
- b. Discuss the importance of generators, transformers, and coils
- c. Explain electromagnetic induction

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: ELECTRICITY AND MAGNETISM

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Conduct laboratory activities to allow students to generate static charges, establish a charge on the electroscope, and use the electroscope to study other charges. This is especially effective during cold months when inside air is dry. (All static charges are due to movement of electrons; friction between materials causes one object to gain electrons while the second object loses electrons. Plastics and synthetic materials, as well as wool, are effective. Have students comb hair and test charge of comb.)
- b. Discuss the implications of the observations from the laboratory activity. Lightning is a large discharge of static electricity. (e.g., Cosmetology: static electricity in hair; Electrical/Electronics: individuals get static charge that jump to light switches and electronic devices; Health Occupations: static discharge in certain volatile materials can be dangerous; Business/Marketing: effect of static electricity on computers.)

2. (P. O. #2)

- a. Help students study and read simple circuit diagrams. (Present simple electrical diagrams that are easily understood. Introduce symbols used to represent switches, lights, electrical sources, and fuses. Introduce concept of series circuits where all electrons go same way, and parallel circuits where electrons at junction divide to follow one of two or more "parallel" wires.)
- b. Have students construct circuit diagrams from verbal descriptions.
- c. Have students construct series and parallel circuits and test the circuits for voltage and amperage. (Circuits can be constructed from dry cells, wire connectors, and flashlight bulbs. Most connections can be easily taped together in simple circuits. Effect of cells in series as well as bulbs in series and parallel becomes apparent.)
- d. Use Ohm's Law to calculate resistance. Check answers, using an ohmmeter. (Ohm's Law, $R = V/I$ shows relationship between resistance, R, voltage, V, and electric current, I. Show with simple algebra how it can be rearranged to solve for any of the three, given the other two. Use data from 2c to calculate resistance when meters are used to measure voltage and current.)
- e. Study house plans to investigate electrical circuits. (e.g., Agriculture: wiring diagram of farm structures; Construction and Building Maintenance: wiring diagrams for houses and other buildings related to building codes; Drafting: electrical circuits incorporated in some building plans; Vehicle Maintenance and Repair: circuit diagrams of vehicles.)
- f. Examine the underwriters' code for construction in homes. (For basic understanding of why the code exists, look at requirements for kitchen circuits.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: PHYSICS APPLICATIONS
TOPIC: ELECTRICITY AND MAGNETISM

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

3. (P. O. #3)

- a. Allow students to experience forces of repulsion and attraction between strong magnets.
- b. Have students magnetize (or at least try to magnetize) objects, using an object of their choice and a strong magnet. (Stroke materials in one direction to magnetize.)
- c. Demonstrate and explain loss of magnetism in a magnet when a keeper is removed.

4. (P. O. #4)

- a. Conduct a laboratory activity in which students construct and test an electromagnet. (Simple electromagnets consist of wire wrapped around a nail. Ends of wire are attached to dry cell. Experiment with different amounts of wire and numbers of dry cells. Electromagnets are found in many places: farm equipment, household appliances, door bells, and certain types of switches.)
- b. Allow students to test the field around a magnet, using a magnetic compass.
- c. Demonstrate the current in a wire when it moves through a magnetic field.
- d. Conduct class activities, using hand-cranked generators.

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS

OVERVIEW OF THE MODULE

GOAL

The purpose of this module is to broaden and deepen student understanding of chemical terminology; chemical terminology; chemical reactions; chemical hazards; and material structures, properties, and testing. This module should broaden the student's application of chemical and material science to the home and in occupations and develop an awareness of chemical hazards.

DESCRIPTION

The Chemical and Material Science Applications module is a nine-week (27-hour) segment of the Occupationally Related Science Syllabus. The four core areas of instruction are: Chemical Terminology, Chemical Reactions, Chemical Hazards, and Material Science/Testing. Since chemical terminology is taught in previous science courses, emphasis should be placed on the other sections. This module includes suggestions for both classroom instruction and laboratory activities.

Chemical Terminology. This topic emphasizes chemical terminology used in occupational areas and life situations.

Chemical Reactions. Introduces students to reactions that apply to daily life and in occupations.

Chemical Hazards. Introduces students to potential chemical hazards, including definitions, reporting methods, and fire hazards.

Material Science/Testing. Presents atomic structure and material structure, and applies basic knowledge in testing materials to performance of materials.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Classify elements and explain the use of elements in occupations
2. Classify compounds and explain the use of compounds in occupations
3. Classify mixtures and explain the use of mixtures in occupations
4. Explain synthesis reactions and list examples of synthesis reactions in occupations
5. Explain decomposition reactions and list examples of decomposition reactions in occupations
6. Explain neutralization reactions and list examples of neutralization reactions in occupations
7. Explain the effect of various factors upon the rates of chemical reactions
8. Compare the terms toxic and hazardous
9. Identify methods of expressing toxic doses and allowable levels of contamination of hazardous materials

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

10. Identify common chemical hazards in the workplace and environment, and list their effects
11. Classify fires according to category, and indicate appropriate methods for handling them
12. Explain various molecular forces, models and interpret diagrams
13. Explain the relationship of structures and properties, and how changes in structures effect properties
14. Design and conduct material test experiments on selected occupational materials

ESTIMATED MINIMUM TEACHING TIME: 27 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS

CONTENT OF THE MODULE

- * I. Chemical Terminology
 - * A. Elements
 - *1. Metals
 - *2. Nonmetals
 - *3. Metalloids
 - * B. Compounds
 - *1. Acids
 - *2. Bases
 - *3. Salts
 - *4. Organic substances
 - * C. Mixtures
 - *1. Solutions
 - 2. Suspensions
 - 3. Colloids
- * II. Chemical Reactions
 - * A. Synthesis
 - *1. Oxidation
 - 2. Photosynthesis
 - 3. Dehydration synthesis
 - 4. Esterification
 - 5. Polymerization
 - * B. Decomposition
 - *1. Hydrolysis
 - 2. Fermentation
 - 3. Saponification
 - 4. Cracking
 - * C. Neutralization
 - *1. Acid and base
 - *2. Oxidizer and reducer
 - 3. Developer and stop
 - 4. Permanent and neutralizer
 - 5. Chlorinator and antichlorinator
 - 6. Dye and dye stop
 - 7. Shrinkage and shrinkage control
 - * D. Altering reactions
 - *1. Accelerators
 - *a. Temperature
 - b. Catalysts (positive and negative)
 - c. Surface area
 - d. Concentrations

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS

CONTENT OF THE MODULE, continued

- *2. Preventing reactions
 - *a. Surface protection
 - *b. Internal protection
- 3. Inhibitors
 - a. Antioxidants in rubber industry
 - b. Antipolymerizing chemicals
 - c. Food preservatives
 - d. Antidrying agents

* III. Chemical Hazards

- * A. Terminology
 - *1. Toxic, acute and chronic
 - *2. Hazardous
- * B. Toxic doses/hazardous levels
 - *1. LD (lethal dose), LC (lethal concentration)
 - *2. TLV (threshold limit values)
 - *3. Standard hazardous chemical data
- * C. Hazards in the workplace
 - *1. Organics and heavy metals
 - *2. Overexposure
- * D. Fire classification and procedures for handling
 - *1. Class "A" fire
 - *2. Class "B" fire
 - *3. Class "C" fire
 - *4. Class "D" fire

* IV. Materials Science/Testing

- * A. Materials science fundamentals
 - *1. Using models
 - 2. Graphic representations
 - 3. Atomic structures
 - 4. Intermolecular forces
 - 5. Simple phase diagrams
- * B. Material structures and properties
 - *1. Structures
 - *a. Gases
 - *b. Liquids and solutions
 - *c. Solids
 - *1) Crystals
 - *2) Metals and alloys
 - 3) Ceramics
 - 4) Cerments (ceramic and metal)

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS

CONTENT OF THE MODULE, continued

- 5) Polymers
- 6) Concrete and asphalt
- 7) Fiber composites
- 8) Laminates and surface coatings
- 9) Wood and cellulosic materials

- *2. Properties
 - *a. Mechanical
 - *b. Electrical and magnetic
 - *c. Thermal and chemical
 - *d. Surface
- * C. Materials testing
 - 1. Design of material tests
 - 2. Classification of tests
 - 3. Components of testing
 - 4. Sample tests

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL TERMINOLOGY

GOAL

Upon successful completion of this topic, students should be able to use chemical terminology correctly as part of their daily vocabulary.

DESCRIPTION

This terminology topic contains three subtopics: Elements, Compounds, and Mixtures. Each subtopic presents chemical terminology that will help the student in occupational areas or in life situations.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Classify elements and explain the use of elements in the home and in occupations
2. Classify compounds and explain the use of compounds in the home and in occupations
3. Classify mixtures and explain the use of mixtures in the home and in occupations

ESTIMATED MINIMUM TEACHING TIME: 4 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL TERMINOLOGY

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will identify and classify selected elements, interpret chemical symbols for elements, and describe atomic particles.

In order to do this, the student must be able to:

- a. Classify elements into appropriate categories based on their properties
 - b. List subatomic particles
 - c. Identify elements from their chemical symbols
 - d. Explain properties characteristic of selected elements
2. Following appropriate instruction, the student will classify compounds and list common properties of compounds.

In order to do this, the student must be able to:

- a. Classify compounds into appropriate categories based on their formulas
 - b. List examples of compounds used in the home and in occupations
 - c. Explain properties characteristic of compounds
3. Following appropriate instruction, the student will define mixtures and classify mixtures based on their chemical properties.

In order to do this, the student must be able to:

- a. Classify mixtures into appropriate categories based on their properties
- b. List examples of mixtures used in the home and in occupations
- c. Explain the differences between compounds and mixtures

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)
 - a. Have students prepare a table of information of elements used in the home and in occupations.

Example:

Element	Classification	Property	Occupational Use
gold	metal	jewelry/inactive	microcircuitry
sulfur	nonmetal	production of sulfuric acid	
silicon	metalloid	semiconductor	transistors

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL TERMINOLOGY

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

1. (P. O. #1) continued

- b. Have students prepare a collection of elements used in the home.
- c. Have students examine a sampling of elements, and classify them into categories of solids, liquids, and gases. (e.g., Agriculture: demonstrate and discuss the importance of different elements found in fertilizers, as they relate to proper storage and effectiveness over periods of time.)
- d. Have students determine if a sampling of elements are metals (conductors) or nonmetals (nonconductors) by testing the element's ability to conduct an electrical current. This can be done by using batteries, clip leads, bulb and socket (e.g., Electrical/Electronics: have students make simple battery cells and test the low current outputs based on the combinations of metals used.)
- e. Have students examine a sampling of metals, metalloids, and nonmetals. After the examination, relate their position on the Periodic Table of Elements to their classification (e.g., Precision Metals: discuss the position on the chart of pure metals and elements that are used to create metal alloys. Have students relate the positions on the chart to the properties of selected elements.)

2. (P. O. #2)

- a. Have students prepare a table of information of compounds used in the home and in occupations.

Example:

Element	Classification	Property	Occupational Use
sugar	organic	cooking	sweetner
sodium hydroxide	base	reacts with fats	oven cleaner
sodium chloride	salt	cooking	flavoring
hypochlorous	acid	oxidizer	bleach

- b. Have students prepare a compound collection, using compounds commonly found in the home. (e.g., Cosmetology: have students explore the similarities between commercial cosmetic products and compounds found in the home.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL TERMINOLOGY

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

3. (P. O. #3) continued

- (e.g., Graphic Communications: have students prepare a brochure or video production on use and storage procedures for products used in the home which may be presented to other students or community members.)
- b. Have students read the ingredients in mixtures such as paints, medicines, foods, etc., and list the compounds or elements they contain. (Home Economics and Health Occupations: discuss safe storage and the need for proper labeling of home products; Vehicle Maintenance and Repair and Construction and Building Maintenance: discuss the proper disposal of waste products to ensure a clean environment.)
 - c. Have students prepare a simple mixture. (Ingredients could be salt, flour, sugar, sand or other readily available household items.) Compare properties of original materials before they were mixed and after they are mixed. (e.g., Food Services: demonstrate and discuss the importance of combinations of ingredients, such as in promoting yeast growth.)
 - d. Have students prepare a chart comparing the differences between compounds and mixtures.
 - e. Have students prepare a mixture of salt and water and a mixture of sand and water. Compare the properties and appearance of each mixture. Relate each mixture to the following terms: homogeneous, heterogeneous, solution, suspension.
 - f. Have students prepare a mixture of vegetable oil and water. Shake the mixture vigorously and record observations. Have students relate to the following terms: suspension, emulsion, colloids. (e.g., Vehicle Maintenance and Repair: demonstrate a mixture of water and gas or water and oil, and discuss the importance of carburetor and crankcase maintenance.)
 - g. Have students prepare a package of gelatin mix (Jello). Have students relate to the following terms: suspension, emulsion, colloids. (e.g., Graphic Communications: demonstrate and discuss these terms as they relate to the manufacturing and packaging of film and in developing.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL REACTIONS

GOAL

Upon successful completion of this topic, the student will demonstrate an understanding of common chemical reactions and be aware of chemical reactions that occur in various industries or occupations. Students will identify chemicals, classify reactions, and relate factors that affect chemical reactions in occupational situations.

DESCRIPTION

The chemical reactions topic contains the subtopics: synthesis reactions, decomposition reactions, neutralization reactions, and altering reactions. Each subtopic is applied to reactions in daily life and in various occupations.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Explain the meaning of synthesis reactions and identify examples of synthesis reactions that occur in various occupations
2. Explain the meaning of decomposition reactions and identify examples of decomposition reactions that occur in various occupations
3. Explain the meaning of neutralization reactions and identify examples of neutralization reactions that occur in various occupations
4. Explain the effect of various factors upon the rate of chemical reactions

ESTIMATED MINIMUM TEACHING TIME: 6 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL REACTIONS

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will interpret and classify chemical synthesis reactions.

In order to do this, the student must be able to:

- a. Explain the meaning of a synthesis reaction
- b. Cite examples of synthesis reactions in the home
- c. Cite examples of synthesis reactions in that occur in the work place

2. Following appropriate instruction, the student will interpret and classify chemical decomposition reactions.

In order to do this, the student must be able to:

- a. Explain what is meant by a decomposition reaction
- b. Cite examples of decomposition reactions in the home
- c. Cite examples of decomposition reactions that occur in a work environment

3. Following appropriate instruction, the student will interpret and classify neutralization reactions.

In order to do this, the student must be able to:

- a. Explain the meaning of a neutralization reaction
- b. Cite examples of neutralization reactions in the home
- c. Cite examples of neutralization reactions in that occur in a work environment

4. Following appropriate instruction, the student will relate variables to chemical reaction rates.

In order to do this, the student must be able to:

- a. Explain the effect of variables on reaction rates
- b. Explain the advantages and disadvantages of food additives
- c. Explain the effects of chemicals on the environment

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL REACTIONS

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Have students prepare a table of information about chemical reactions in the home and in various occupational pursuits.

Example:

Reaction	Classification	Purpose	Factors
epoxy glues	synthesis	bonding agent	hardener
aging meat	decomposition	tenderizer	temperature
baking soda	neutralizer	raise pH	acids
food preservatives	antioxidant	increase life	temperature

(e.g., Technology: discuss the implications of byproducts of industrial chemical reactions and their possible negative effects on the environment. Explore alternative reactions that appear less threatening; Business and Marketing: discuss business ethics vs. economic profits in chemical production plants, and the cost of serious accidents.)

- b. Using chemical reference materials, have students define each type of reaction listed and show chemical equations to represent each type. (e.g., Electrical/Electronics: describe the chemical synthesis and decomposition of battery cells, and demonstrate why the reactions have limits.)
- c. Have students perform the synthesis reaction of esterification.

Combine 3 ml of methanol with 0.2g of salicylic acid and heat gently for several minutes. Carefully note the odor.

2. (P. O. #2)

- a. Have students select a specific chemical reaction in the home or an occupation and prepare a report containing information on: the history, reaction, controls, classification, and importance. (e.g., Health Occupations: discuss the relations of improper medications or reactions to mixing medicines with alcohol or drugs, or reactions to repetitive use of selected medicines.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL REACTIONS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

- b. Have students perform the decomposition reaction of electrolysis (e.g., decomposition of water, using a 6- or 12-volt battery. Gases may be collected in test tubes.)

(e.g., Technology: discuss the importance of this application for intermittent alternative energy sources.)

- c. Have students define each of the terms listed, using chemical reference materials. (e.g., Vehicle Maintenance and Repair: use chemical references to describe the synthesis of white powder on battery terminals. Demonstrate proper treatment and prevention procedures.)

3. (P. O. #3)

- a. Have students prepare a report of chemicals used in their school.

Example:

Chemical	Where Used	Purpose/Reason
alcohol	office	duplication/solvent
ammonia	cleaning	solvent/disinfectant
salt	cafeteria	flavoring/improve taste

(e.g., Food Services, Agriculture, and Construction and Building Maintenance: discuss with the cafeteria or maintenance and grounds personnel the daily use of chemicals and the safety precautions taken.)

- b. Have students perform the neutralization reaction of acid-base. (Add an antacid tablet to a weak acid solution (HCl), using phenolphthalein as an indicator.

(e.g., Agriculture: demonstrate and discuss possible neutralizing agents for acidic or basic soils, and methods for testing.)

- c. Have students list and define chemical terms and reactions used in their occupations. (e.g., Graphic Communications: describe chemical reactions in film developing, including the correct order of processing and the use of "stop baths".)

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL REACTIONS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

4. (P. O. #4)

- a. Have students survey industries, farmers, and homemakers, and prepare a table of information of chemicals important to them and why. (e.g., Business and Marketing: have students perform market surveys of less toxic products at constant or increased prices and have them diagnose consumer reactions.)
- b. Have students compare the rate of dissolving of a sugar cube and an equal amount of granulated sugar. Stir both solutions. (e.g., Vehicle Maintenance and Repair and Electrical/Electronics: demonstrate and discuss the importance of plate surface area to battery power.)
- c. Have students compare the rate of dissolving of sugar cubes in cold water and hot water. (e.g., Cosmetology: demonstrate and discuss the effects of temperature variances in preparing and applying chemical agents to patrons; Food Services: demonstrate and discuss the effects of temperature on micro-organism growth, positive and negative, such as bacteria and yeast.)
- d. Have students obtain a piece of fresh homemade bread (no chemicals added) and a piece of fresh store-purchased bread. Wrap each piece separately in a moist polyethylene sandwich bag. Note the rate at which mold forms on each piece of bread. (e.g., Home Economics: describe and compare commercial and natural preservatives and methods of avoiding the use of inhibitors; Food Services: discuss the trade-offs of using additives vs. altering the taste of selected foods.)
- e. Have students coat completely a small piece of zinc metal with wax. Place the wax-covered piece of zinc and an uncoated piece of zinc into a 6M HCl solution. Note the behavior of each piece of zinc. (e.g., Precision Metals: demonstrate the use of corrosion preventative reactants by using a controlled experiment; Construction and Building Maintenance: demonstrate and discuss the importance of paints, preservatives, coatings, and other material treatments to protect from weather and vermin.)
- f. Have students prepare a table of information on the effects of chemical reactions.

Example:

Factor	Effect
musk in perfumes	slows the evaporation rate
steel cans	coated with tin to prevent rusting
water	accelerates the digestion of food
lime	accelerates the hardening of concrete

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL HAZARDS

GOAL

Upon successful completion of this topic, the student should be able to demonstrate an understanding of common chemical hazards in the workplace.

DESCRIPTION

The chemical hazards topic introduces chemical hazards, including definitions, reporting methods, and fire dangers.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Compare the terms toxic and hazardous
2. Identify methods of expressing toxic doses and allowable levels of contamination of hazardous materials
3. Identify common chemical hazards in the workplace and environment and list their effects
4. Classify fires according to category and indicate appropriate methods for handling them

ESTIMATED MINIMUM TEACHING TIME: 7 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL HAZARDS

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will demonstrate an understanding of the terms toxic and hazardous.

In order to do this, the student must be able to:

- a. Differentiate between the terms toxic and hazardous
 - b. Explain the difference between acute and chronic toxicity
 - c. Explain why extremely small doses of certain toxic chemicals are hazardous (e.g., persistence, bioaccumulation)
2. Following appropriate instruction, the student will explain methods used to express hazardous levels of chemicals.

In order to do this, the student must be able to:

- a. Explain what is meant by toxic doses such as a LD (lethal dose) or LC (lethal concentration) and the various ways these can be expressed
 - b. Explain what is meant by Threshold Limit Values (TLV's) for airborne contaminants, and indicate the three categories commonly used to express these values - time weighted average (TWA), short-term exposure limit (STEL), and ceiling (C)
 - c. Interpret standard data provided for hazardous chemicals such as flash point, ignition temperature, flammability limits, type of hazard, hazard ratings, and precautions
3. Following appropriate instruction, the student will describe the effect of selected chemical hazards in the work place and environment.

In order to do this, the student must be able to:

- a. List examples of common organic and heavy-metal hazards in the work place and environment
 - b. Indicate problems caused by overexposure to these chemicals
4. Following appropriate instruction, the student will list hazards of chemical fires and differentiate between the four basic classifications of fire according to the nature of combustible materials.

In order to do this, the student must be able to:

- a. Describe a Class "A" fire and indicate an effective means of extinguishing it
- b. Describe a Class "B" fire and indicate an effective means of extinguishing it
- c. Describe a Class "C" fire and indicate an effective means of extinguishing it
- d. Describe a Class "D" fire and indicate an effective means of extinguishing it

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL HAZARDS

SUGGESTED INSTRUCTIONAL STRATEGIES

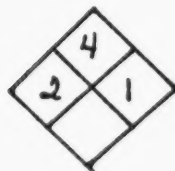
1. (P. O. #1)

- Have students prepare a diagram or flowchart which illustrates bioaccumulation of chemicals, such as DDT, PCB's, or mercury, in the ecosystem (e.g., Welding - acetylene; Cosmetology - peroxide; Vehicle Maintenance and Repair - gasoline).
- Familiarize students with the hazard symbol developed by the National Fire Protection Agency (NFPA) to indicate hazards associated with substances in regard to health (toxicity), fire (flammability), and reactivity (explosiveness). (e.g., Construction and Building Maintenance: in paint pigments and paint stripper.)

Example:



general symbol



ethyl ether

4 = highest degree of hazard
0 = lowest degree of hazard

- Have students prepare a table of substances, classifying them according to their hazards.

Example:

Substance	Health	Fire	Reactivity
asbestos	high	nil	nil
ethyl alcohol	low-nil	high	nil
sulfuric acid	high	nil	violent with H ₂ O
nitroglycerine	low-nil	nil	high

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL HAZARDS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

1. (P. O. #1) continued

- d. Have students prepare a table of substances, classifying them according to their toxicity.

Example:

Substance	Acute	Chronic
asbestos	no	yes
PCB's	yes	yes
formaldehyde	no	yes
chromium	yes	yes

2. (P. O. #2)

- a. Have students consult various handbooks to interpret data provided for hazardous chemicals (e.g., Health Services lethal vs. toxic).
- b. Have students prepare a list of terms used to express toxicity and explain what they mean.

Example:

Terminology	Explanation
orl-hmn LDLo: 29 mg/kg orl-rat LD50: 320 mg/kg inh-hmn TCLo: 20 ppm	- o Lowest published lethal dose taken orally by a human: 29 mg substance per kg body weight. - o Lethal oral dose for a 50% kill of rats in a test sample: 320 mg substance per kg body weight. - o Lowest published toxic dose inhaled by a human, 20 parts substance per million parts air.

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL HAZARDS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

- c. Have students prepare a list of terms used to express threshold limits for airborne contaminants (e.g., Construction and Building Maintenance: ASHRAE handbook; Health Occupations, Food Services, Home Economics: Handbook of Chemistry and Physics).

example:

Terminology	Explanation
TLV-TWA: 2400 mg/m ³	o The time-weighted average concentration for a normal 8-hr. workday, or 40-hr. work-week, to which nearly all workers may be repeatedly exposed, day after day, without ill effect: 2400 mg substance per cubic meter of air.
TLV-C: 5 ppm	o The concentration which should not be exceeded even instantaneously: 5 parts substance per million parts air.

3. (P. O. #3)

Have each student prepare a report on a different hazardous chemical and give a brief presentation to the class. (e.g., Home Economics: cleaning fluids; Construction and Building Maintenance: paints, furniture stripping.)

The report should include:

A discussion of the source of the particular hazard (e.g., acrylonitrile - production of synthetic fibers, plastics, and acrylics, and the allowable limits in the workplace or environment).

A discussion of the problems caused by overexposure to a chemical (e.g., acrylonitrile - acute symptoms include headaches, dizziness, tremors, and jaundice. Chronic exposure can lead to kidney and liver damage and failure of the central nervous system. It is also a suspected carcinogen).

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: CHEMICAL HAZARDS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

4. (P. O. #4)

Have students identify types of fires and methods of control, after seeing film strips or video tapes presenting specific situations. (e.g., Vehicle Maintenance: engine fire; Agriculture: electrostatic discharge, spontaneous combustion.)

Example:

Type of Fire	Method of Control
burning gasoline burning metal	water? carbon dioxide? dry powder? water? carbon dioxide? sand?

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: MATERIALS SCIENCE/TESTING

GOAL

Upon successful completion of this topic, students will understand the concepts of atomic structures and forces present within materials. The student will be able to apply the concepts to explain structures and properties of materials found in the home and in various occupations. The student will also be able to test materials and explain why materials meet design requirements, or fail based on structural concepts.

DESCRIPTION

This topic is organized into three subtopics. The first introduces atomic structures and forces and their representation by models. The second subtopic builds upon fundamentals to present material structures and their effect on material properties. The last section applies basic knowledge in testing materials to the understanding of the selection and performance of materials.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The student will be able to:

1. Explain material science fundamentals (atomic structures and forces, and phase diagrams), using models and graphic representations
2. List structures that affect material properties, and explain how changes in structures result in property changes
3. Design and conduct material test experiments on related occupational materials

ESTIMATED MINIMUM TEACHING TIME: 10 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: MATERIALS SCIENCE/TESTING

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will design models and graphic representations to describe material atomic structures and forces, structural changes due to working material, and phase changes of related materials.

In order to do this, the student must be able to:

- a. Describe why models and graphic representations are used, and how they enable better understanding of microscopic structures and forces
 - b. Explain a simple three-phase diagram for water
 - c. Graphically demonstrate structural changes in a material as it is altered occupationally
2. Following appropriate instruction, the student will identify and compare various materials based on their structures and properties.

In order to do this, the student must be able to:

- a. Describe the different structural forms that material may take
 - b. List various properties inherent in different materials
 - c. Compare material properties and structures and identify specific materials for related occupational applications
 - d. Describe and demonstrate structural or property inadequacies that have resulted in material failures
3. Following appropriate instruction, the student will design and conduct a material testing experiment and record and analyze the results.

In order to do this, the student must be able to:

- a. List and explain the type of testing classification most appropriate to the test that is to be performed
- b. List and describe the components of the testing procedures
- c. Record and analyze the test results

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: MATERIALS SCIENCE/TESTING

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Demonstrate to students the effects of materials that undergo phase changes. Several examples include:
 1. Showing that ice water temperature remains constant even though the ice is melting. (e.g., Technology: demonstrate and discuss the importance of phase-changing solutions in heat energy storage; Precision Metals: discuss phase diagrams of metal alloys and describe changes occurring in material properties due to the introduction of small amounts of selected elements or compounds, as with carbon content in iron.)
 2. Showing the force exerted by water as it freezes. (It will crack a cast iron container.) (e.g., Vehicle Maintenance and Repair: demonstrate and discuss the importance of soft plugs.)
 3. Showing work hardening by bending a wire back and forth until it breaks. (Ask why it gets hot.) (e.g., Precision Metals, Vehicle Maintenance and Repair: demonstrate work hardening and its implications to material failure. Discuss preventative maintenance.)
 4. Asking students why a cold drink sweats. (e.g., Construction and Building Maintenance: discuss condensation moisture problems in the building envelope, and demonstrate ways of prevention; Vehicle Maintenance and Repair: discuss condensation problems in fuel lines and prevention procedures.)
 5. Showing students that by adding salt, water boils at higher temperature. (e.g., Food Service: demonstrate the effects of boiling rates by adding salt to water and relate to the water phase diagram.)
- b. Have students construct demonstration models of materials common to their occupation. Have them graphically illustrate the structural or property changes that occur when the material is shaped, formed, or altered to meet an occupational need. (e.g., Precision Metals: demonstrate and discuss the effects of heat on metal forming and fabrication, including tempering, annealing, hardening, case hardening and the related structural changes.)

2. (P. O. #2)

- a. Have students list various materials used in their chosen occupation and describe the structures and important properties associated with the materials selection. (e.g., Home Economics: demonstrate and describe properties of selected clothing materials such as cotton, wool, synthetics, and various combinations; Graphic Communications: discuss the coding system for photographic paper and describe the properties that match the type of paper.)
- b. Give students hypothetical situations involving the selection of materials and have them explain their decisions. This could be done several ways. For example:
 1. Describe the structure and properties of an unknown material and have students discuss possible applications. (e.g., Technology: use two groups of students and have some students make up hypothetical materials brought back from exploration on the moon. Have other students develop applications. Then reverse the roles between groups.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: CHEMICAL AND MATERIAL SCIENCE APPLICATIONS
TOPIC: MATERIALS SCIENCE/TESTING

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

2. Give students an occupational material requirement and have them invent a new material with the appropriate properties. (e.g., Electrical/Electronics: have students attempt to design a substitute for copper wiring that is economical and that can be incorporated into building panels for ease of installation.)
- c. Have students bring to class an item related to their future occupation. Have them list the various materials that comprise that item and their corresponding properties. Have them list any materials that were used during the production of that item. Relate the cost of the item compared to the scarcity of the materials, and the amount of resources needed to shape, form, or alter the material. (e.g., Business/Marketing: have students perform a market study of a new product using several material choices, and possibly prices. Discuss the finances involved in the selection and processes of producing for selected materials.)
- d. Bring in an occupationally related piece of equipment that has malfunctioned. Have students identify the material that has failed and describe the structural or property inadequacies. Have them suggest alternative materials to improve the quality of the item and relate this to the new cost of the item. (e.g., Home Economics and Business/Marketing: describe and discuss consumer protection and product warranties.)

3. (P. O. #3)

- a. Have students design a test for an occupationally related material. When helping them design the test, refer to Davis, et. al., The Testing of Engineering Materials, 1982, McGraw Hill.
(e.g., Health Occupations: investigate the health industries material testing. Discuss or debate the ethics and/or importance of testing on human or animal subjects.)
- b. Discuss with students different approaches to materials testing and the relationship of those approaches to the materials that are utilized in their occupations. Demonstrate the difference between destructive and nondestructive testing and the necessity for both. (e.g., Technology: discuss the importance of rigorous materials testing for equipment used in space exploration.)
- c. Visit a local industry that has a quality-control facility. Based on this experience, have students set up and perform simple materials tests on occupationally related material. Have them record and analyze their results. (e.g., Electrical/Electronics: demonstrate color coding and tolerances of electrical components; Precision Metals & Drafting: demonstrate and discuss tolerances in fitting machined parts; Construction and Building Maintenance: demonstrate simple apparatus for testing materials for strength, sound absorption, insulative value, etc.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS

OVERVIEW OF THE MODULE

GOAL

This Occupationally Related Life Science Applications module is designed to help students broaden and deepen their understanding of key concepts in the environment pertaining to biological science. In addition to developing a holistic understanding of basic plant and animal relationships, students will focus on the important interrelationships that exist between organisms and their environment.

The intent of this module is to promote a better understanding of human interactions with the natural environment and to provide a base for intelligent decision-making with regard to the utilization of plant and animal resources.

DESCRIPTION

This Occupationally Related Life Science Applications module is a nine-week (27-hour) outline divided into four major topics. These topics are closely interrelated and cover the minimal amount of information necessary to make ecologically sound decisions with regard to resource utilization.

Spheres of the Ecosystem. Introduces students to the interrelationships of the living and non-living components of the ecosystem.

Cycles of the Ecosystem. This topic describes the important cycles of the ecosystem and relates them to living processes.

Energy Flow in an Ecosystem. This topic describes the flow of energy from the sun through plants and animals. The energy pyramid is presented in terms of usable energy and biomass.

Human Ecological Relationships and Adaptations. Presents population growth and carrying capacity. This topic also relates major concepts in genetics to organismal adaptations and human ecological adaptations.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Define the major ecological levels of organization of the living world
2. Explain the movement of earth materials in the rock cycle
3. Describe the water cycle
4. Describe the relationship between photosynthesis and the carbon cycle
5. Describe the relationship between respiration and the oxygen cycle
6. Explain the importance of nitrogen in the structure of amino acids/proteins
7. Describe the nitrogen cycle

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS

8. Describe the flow of energy in an ecosystem
9. Define autotrophic nutrition
10. Define heterotrophic nutrition
11. Describe the energy relationships of an ecosystem in terms of food chains and food webs
12. Describe the flow of energy in an ecosystem in terms of the food pyramid/biomass
13. Relate the concept of carrying capacity to population growth of all organisms
14. Demonstrate and describe how basic techniques of soil, forest, and wildlife conservation are applied
15. Define and give examples of the major principles of genetics

ESTIMATED MINIMUM TEACHING TIME: 27 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS

CONTENT OF THE MODULE

- * I. Spheres of the Ecosystem
 - * A. Organization of an ecosystem
 - * 1. Abiotic factors
 - * a. Light
 - * b. Temperature
 - * c. Precipitation
 - * d. Soil
 - * e. Minerals
 - 2. Biotic organization
 - a. Populations
 - b. Species
 - c. Communities
 - d. Ecosystems
 - 3. Spheres of the earth
 - a. Lithosphere
 - b. Hydrosphere
 - c. Atmosphere
 - d. Biosphere
 - 4. Ecosystem concepts
 - a. Interdependence
 - b. Energy flow
 - c. Cycles
 - d. Carrying capacity
 - e. Diversity
 - f. Community/niche
 - g. Patterns
 - h. Competition
 - i. Adaptation/evolution
 - j. Change
 - k. Human/technology influence
 - * B. The lithosphere
 - * 1. Rock cycle
 - * a. Sedimentary rock
 - * b. Sediments (soil)
 - c. Igneous rock
 - d. Metamorphic rock
 - * 2. Soils
 - * a. Soil development
 - b. Soil horizons
 - c. Soil classification
 - d. Biological activity
 - e. Soil testing
 - 3. Soil maintenance
 - a. Natural and synthetic fertilizers
 - b. Conservation

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS

CONTENT OF THE MODULE, continued

- c. Irrigation
 - d. Tillage equipment/techniques
 - e. Crop rotations
 - f. Cropping practices
- * C. The hydrosphere
 - * 1. The water cycle
 - * a. Evaporation
 - * b. Condensation
 - * c. Precipitation
 - * d. Subsurface water zones
 - * 2. Water and life
 - * a. World biomes and precipitation
 - * b. Photosynthesis and water
 - * c. Respiration and water
 - 3. Water budget
 - a. Average annual precipitation
 - b. Actual evapotranspiration
 - c. Potential evapotranspiration
 - d. Usage
 - e. Surplus/deficit
 - f. Recharge
- * II. Cycles of the Ecosystem
 - * A. Carbon and photosynthesis
 - * 1. Carbon dioxide in the atmosphere
 - * 2. Photosynthetic equation
 - * 3. Consumption of plant carbohydrates by animals
 - * 4. Respiration and decay
 - * 5. Combustion
 - * B. Oxygen and respiration
 - * 1. Oxygen in the atmosphere
 - 2. Oxygen dissolved in the water
 - 3. Animal consumption of oxygen for respiration
 - 4. Production of carbon dioxide by respiration
 - * C. Nitrogen in amino acids
 - 1. Basic structure of amino acids
 - 2. Basic structure of protein molecules
 - 3. Plants: nitrates to amino acids
 - 4. Animals: food containing amino acids
 - * D. Nitrogen cycle
 - 1. Nitrates
 - 2. Plants and plant protein
 - 3. Animals and animal protein

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS

CONTENT OF THE MODULE, continued

4. Decomposers (saprophytes)
5. Ammonia
6. Nitrifying bacteria
7. Legumes and nitrogen-fixing bacteria

* III. Energy Flow of an Ecosystem

- * A. The sun is the source of energy for ecosystems
 - * 1. Energy requirement for metabolism
 - * 2. Food chains
 - * 3. Food webs
- * B. Autotrophic nutrition
 - 1. Photosynthesis converts radiant energy into chemical energy
 - a. Structure of chlorophyll containing plant cells
 - b. Structure of a leaf
 - c. Structure of plant seeds (monocots and dicots)
 - 2. Efficiency of photosynthesis
 - 3. Production of usable energy for the ecosystem
- * C. Heterotrophic nutrition
 - 1. Consumption of other organisms for energy
 - a. Ingestion by unicellular heterotrophs
 - b. Ingestion by multicellular heterotrophs
 - c. Cell structure of a unicellular heterotroph
 - 2. Herbivores
 - 3. Carnivores, predators, and scavengers
 - 4. Omnivores
 - 5. Saprophytes
- * D. Food chains
 - 1. Producers
 - 2. 1st-level consumers
 - 3. 2nd-level consumers
 - 4. 3rd-level consumers
 - 5. Decomposers at all levels
 - 6. Complexity of food webs
- * E. Energy pyramid
 - * 1. Producers
 - * 2. 1st-level consumers
 - * 3. 2nd-level consumers
 - * 4. 3rd-level consumers
 - * 5. Relationship of biomass

* IV. Human Ecological Relationships and Adaptations

- * A. Carrying capacity and population growth
 - * 1. Normal growth curve with carrying capacity
 - * 2. Growth curve of human population

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS

CONTENT OF THE MODULE, continued

- *3. Malthusian growth prediction
- *4. Resource utilization
 - *a. Renewable resources
 - *b. Nonrenewable resources
 - *c. Resource reclamation
- * B. Conservation
 - *1. Water conservation
 - *a. Watershed
 - *b. Water and soil conservation
 - *c. Aquifers and soil conservation
 - 2. Soil conservation
 - a. Crop rotation
 - b. Cover crops
 - c. Strip cropping
 - d. Contour farming
 - e. Terracing
 - f. Windbreaks
 - g. No-till planting
 - h. Fertilizers
 - i. Soil/crop banks
 - 3. Forest conservation
 - a. Tree harvesting
 - b. Control of exotic species
 - c. Fire prevention
 - d. Reforestation
 - 4. Wildlife conservation
 - a. Education programs on threatened and endangered species
 - b. Wildlife management by land owners
 - c. Reestablishment of extirpated species
 - d. Ecosystem literacy
 - e. Wildlife carrying capacity
 - 5. Pest control methods
 - a. Quarantine
 - b. Biological control
 - c. Chemical control via pheromones
 - d. Crop rotation
 - e. Irradiation
 - f. Mechanical/trapping
- * C. Genetics
 - *1. Gene-chromosome theory
 - *a. Chromosomes
 - *b. Genes
 - c. Loci
 - d. Alleles

*Core content is identified with an asterisk. The breakdown of content under each item identified with an asterisk should be considered enhancement, to be included at the instructor's option.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS

CONTENT OF THE MODULE, continued

2. Major genetic concepts
 - a. Dominant/recessive
 1. Symbolism (Tt)
 2. Genotype
 3. Phenotype
 4. Homozygous
 5. Heterozygous (hybrid)
 - b. Segregation and recombination
 1. Gametes
 2. Punnett squares
 3. Hybrid cross
 4. Test cross
 5. Back cross
 - c. Incomplete dominance
 - d. Codominance
 - e. Independent assortment
 - f. Gene linkage and sex determination
 - g. Crossing-over
 - h. Sex determination
 1. Autosomes
 2. Sex chromosomes
 3. Karyotypes
3. Genetic applications to plant and animal breeding
 - a. Artificial selection
 - b. Inbreeding
 - c. Hybridization
 - d. Preservation of desirable mutations
4. Genetic research
 - a. Cloning
 - b. Bacterial transformation
 - c. Genetic engineering/recombinant DNA
 - d. Applications of genetic research to occupations

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: SPHERES OF THE ECOSYSTEM

GOAL

Successful completion of this topic will enable students to understand the basic organization of the ecosystem. The student will comprehend the interrelatedness of the living and nonliving components of the ecosystem, and develop a working knowledge of the concepts that govern ecosystems.

DESCRIPTION

This topic introduces the basic organization of the ecosystem. The abiotic factors are defined as nonliving components from which life has evolved. The biotic organization defines how the living component of the ecosystem is organized. In addition, the basic cycles of the lithosphere and hydrosphere are described as the raw materials of the ecosystem, and their cyclic pattern of movement within the ecosystem as presented.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Identify and define the major ecological levels of organization of the living world
2. Explain the movement of earth materials in the rock cycle
3. Describe the water cycle

ESTIMATED MINIMUM TEACHING TIME: 5 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: SPHERES OF THE ECOSYSTEM

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will demonstrate an understanding of the basic levels of organization of the ecosystem.

In order to do this, the student must be able to:

- a. Define the major abiotic factors of the ecosystem
 - b. Define the various levels of biotic organization
 - c. Describe/define the spheres of the ecosystem
 - d. Describe the ecosystem in terms of the major concepts
2. Following appropriate instruction, the student will demonstrate an understanding of the movement of earth materials in the rock cycle.

In order to do this, the student must be able to:

- a. Define the rock cycle
 - b. Describe the factors involved with soil development
 - c. Describe basic characteristics of soil maintenance
3. Following appropriate instruction, the student will demonstrate an understanding of the function of the water cycle and its relationship with the ecosystem.

In order to do this, the student must be able to:

- a. Describe the movement of water through the ecosystem
- b. Analyze the components of a local water budget
- c. Discuss the relationship between soil development and the water budget

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: SPHERES OF THE ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Set up an experiment in the classroom which varies the abiotic factors of bean sprouts (e.g., Agriculture: amount of daylight, daily temperature range, amount of rainfall per month/season/year, texture of soil, use of computers for data manipulation).
- b. Compare plants grown in different wavelengths (colors) of light by surrounding them with colored cellophane (e.g., Agriculture: length of growing season; Business/Marketing, Graphics Communications: graph of results of plant growth for a period of 20 days; Health Occupations: adequate light for work conditions).
- c. Compare the effects of plants grown under different durations of daylight.
- d. Grow plants in different types of soils, such as gravel, top soil, sand, and peat (e.g., Agriculture: soil types; Business/Marketing: price per truck load of each soil type; Construction and Building Maintenance: how soil types affect the size and types of building foundations).
- e. Compare growth rates based on amounts of water (e.g., Agriculture: irrigation, drought; Food and Nutrition: role of water in human growth).
- f. Compare growth rates of plants at different temperatures (e.g., Agriculture: germination of seed, crop maturity rate; Architecture: better greenhouses).
- g. Determine the number of species of plants and animals in a square foot of lawn space and compare with a square foot under a stand of trees (e.g., Health Occupations: use microscopes to identify microscopic plants and animals; Agriculture: identify endemic plant and animal species).
- h. Visit a local pond ecosystem and identify each of the ecosystem concepts. (Apply each concept, using general definitions, to each occupational education sequence; competition in Trade and Industry; diversity of small engines, i.e., lawnmowers in Vehicle Maintenance and Repair.)
- i. Record the changes that occur in a local ecosystem as the seasons change.

2. (P. O. #2)

- a. Have each student bring one golf ball-sized rock to class and determine the type of rock. (e.g., Precision Metal: weigh each sample; Drafting: sketch the shape of individual crystals. Technology, Construction and Building Maintenance: label rock types mined locally.)
- b. Identify the types of rock used in the following building materials: concrete, concrete block, fire brick, building brick, bathroom tile.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: SPHERES OF THE ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

- c. Visit a construction site just after the foundation has been dug and observe the soil horizons/development. (e.g., Agriculture: measure the deepest observed plant root; Construction and Building Maintenance: observe the foundation with respect to the terrain; Drafting: develop a detailed drawing of the soil horizon.)
- d. Have each student bring to class a soil sample in a plastic sandwich bag and make the following group comparisons: color, texture or grain size, presence of roots. Determine the amount of water in each sample by placing exactly 5 grams in a petri dish. Allow the sample to dry for one week and weigh it again.
- e. Obtain pH kits from the local Cooperative Extension office for about \$6 each. Have the students test their own soil samples. Each kit will test 5-6 samples.
- f. Obtain a catalog of fertilizers. Compare the different ratios of N:P:K (nitrogen:phosphorus:potassium) and determine the benefit of each. (e.g., Agriculture: explain the importance and use of various types of fertilizers; Business/Marketing and Graphic Communications: determine which of the fertilizer bags is most "eye catching".)
- g. Invite a guest speaker, such as a Cooperative Extension agent, local farmer, agriculture teacher, local nursery worker, etc., to discuss the importance of soil maintenance and/or the latest techniques of tillage.

3. (P. O. #3)

- a. Diagram the water cycle. Ask students to identify an occupational area which does not require water. Determine the importance of water quality in each occupational education sequence (e.g., Cosmetology: hair and body preparations; Graphic Communications: paint quality).
- b. Diagram the zones of subsurface water (e.g., Agriculture: maintaining water supplies for irrigation; Construction and Building Maintenance: protection of aquifers, underground water and building site selection).
- c. Invite a water well contractor to discuss the business, training, equipment, etc. (e.g., Construction and Building Maintenance: determine the cost of a water well drilling rig; Vehicle Maintenance and Repair: determine common maintenance costs of and repairs to the equipment).
- d. Invite a septic system contractor to discuss the business, training, equipment, etc.
- e. Obtain data from the local National Weather Service concerning the water budget for your area. (Determine the expense of water to occupational areas if water suddenly becomes unavailable.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: SPHERES OF THE ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

3. (P. O. #3) continued

- f. Obtain water budget data from contrasting climates and compare the types of agribusiness in each. (e.g., Graphic Communications: graph data from various climates.)
- g. Using world maps, compare annual precipitation data to demographic data. (e.g., Agriculture, Food Services and Home Economics: relate large scale famine and availability of water.)
- h. Enclose various plants in plastic bags tied off tightly around the base of the stem/trunks to determine the amount of water given off (transpired). (e.g., Agriculture: determine water requirements for crop production.)

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: CYCLES OF THE ECOSYSTEM

GOAL

Upon successful completion of this topic, the student will explain the contributions of individual cycles to the biogeochemical cycle. The student will also be able to distinguish the pathways of essential chemical elements as they move through the ecosystem.

DESCRIPTION

This topic describes the carbon/oxygen nitrogen cycles. The carbon/oxygen cycle is described in terms of photosynthesis (a process which produces oxygen) and cellular respiration (which contributes to the production of carbon dioxide). The nitrogen/nutrient cycle is described as basic to the structure of all life. This is accomplished by defining nitrogen within amino acids, the building blocks of protein molecules.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to.

1. Compare and contrast the relationship between photosynthesis and the carbon cycle
2. Identify and describe the relationship between respiration and the oxygen cycle
3. Explain the importance of nitrogen in the structure of amino acids/protein
4. Describe the nitrogen cycle

ESTIMATED MINIMUM TEACHING TIME: 8 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: CYCLES OF THE ECOSYSTEM

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will demonstrate an understanding of the carbon/oxygen cycle by identifying and describing the relationship between photosynthesis and the carbon/oxygen cycle.

In order to do this, the student must be able to:

- a. Identify the sources of atmospheric carbon dioxide
- b. Identify carbon dioxide as an essential raw material for photosynthesis
- c. Trace the carbon atom as it is converted into carbohydrates by green plants and consumed by animals
- d. Identify combustion as an increasing source of atmospheric carbon dioxide

2. Following appropriate instruction, the student will demonstrate an understanding of the carbon/oxygen cycle by identifying and describing the relationship between cellular respiration and the carbon/oxygen cycle.

In order to do this, the student must be able to:

- a. Identify the sources and locations of atmospheric oxygen
- b. Trace the oxygen atom as it is consumed by animals for use in cellular respiration
- c. Trace carbon dioxide as a waste product of cellular respiration and back to a raw material for photosynthesis

3. Following appropriate instruction, the student will explain the importance of nitrogen as an essential component of amino acids/proteins.

In order to do this, the student must be able to:

- a. Identify the basic structure of amino acids and define amino acids as the building blocks of protein
- b. Describe the importance of plants in converting nitrates to amino acids
- c. Identify animals as consumers of plant synthesized amino acids

4. Following appropriate instruction, the student will describe the main nitrogen cycle as an essential cycle of nutrients in a healthy ecosystem.

In order to do this, the student must be able to:

- a. Trace the pathway of nitrate molecules as raw materials for green plants
- b. Identify green plants as the source of nutrients (producers) for animals
- c. Describe the role of saprophytes in terms of the nitrogen/nutrient cycle
- d. Identify stages of the nitrogen/nutrient cycle including nitrifying bacteria, legumes and nitrogen-fixing bacteria

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: CYCLES OF THE ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Make a class list of possible sources of atmospheric carbon dioxide produced by various occupational sectors. agriculture, commercial, health, industrial, residential, transportation (e.g., Home Economics: yeasts; All Occupational Areas: fire extinguishers; Vehicle Maintenance and Repair: exhaust from combustion engines).
- b. Collect data on the "greenhouse effect" and compare the changing percentile of atmospheric carbon dioxide for the last 75 years (e.g., Food and Nutrition: cast iron skillet vs. aluminum fry pan; Architecture, Construction: summer temperature of a black shingled roof vs. white).
- c. Place a geranium plant in the dark for two days. Cover and completely seal several of the plant's leaves with cellophane to prevent the entrance of carbon dioxide. Expose the plant to direct sunlight for one day. Testing the covered and uncovered leaves for the presence of starch should show little or no starch for the covered leaves. The carbon in plant starch comes from carbon dioxide (e.g., Agriculture: plant growth requirements; Home Economics: source of essential nutrients).
- d. Invite a guest speaker from the local fire department to discuss the gases released due to combustion of plastics and other occupational materials (e.g., Precision Metal Work: mixing combustible gases for welding).
- e. Discuss the Environmental Protection Agency Clean Air Act (e.g. All Occupational Areas: compare fresh air to air in a designated smoking area).

2. (P. O. #2)

- a. Demonstrate the movement of the carbon/oxygen cycle using the following procedure:
 - Obtain some bromthymol blue, anacharis (elodea), and a small aquarium. Several 1-pint jars will work also.
 - Place the elodea in the aquarium full of water and allow it to grow vigorously by keeping the water warm (20-22 degrees C) and providing at least 8 hours of sunlight or equivalent per day for a week.
 - Prepare a 0.1% solution of bromthymol blue by dissolving 0.5 g into 500 ml of water.
 - Turn the solution blue by adding household ammonia water one drop at a time.
 - Blow air through a straw into the solution until it just turns yellow.
 - Add the yellow solution to three sets of two jars of aquarium water as follows: one jar with solution and aquarium water; one jar with solution, water, and a vigorously growing elodea sprig with an end bud.
 - On class day, place one set in direct sunlight, noting the yellow water color. Place another set in the dark to prevent light exposure. After 40 minutes

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: CYCLES OF THE ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2) continued

compare the two sets. The blue indicates indirect evidence of carbon dioxide absorption. Yellow color indicates that carbon dioxide from your exhaled breath is still present.

- b. Capture oxygen gas by placing 5-10 vigorously growing elodea sprigs with freshly cut stems in an inverted container filled with water containing a sodium bicarbonate solution.
- c. Have students obtain information concerning oxygen production by green plants. Compare terrestrial plants with oceanic plants in terms of oxygen production (e.g., All Occupational Areas - importance of adequate ventilation for all oxygen breathing organisms; Technology - oxygen requirements for combustion engines; Agriculture - oxygen requirements for various types of fish).
- d. Diagram the pathway of oxygen molecules in the following organisms: humans, fish, green beans, green algae, etc.
- e. Diagram the pathway of carbon dioxide molecules in the following organisms: humans, fish, green beans, green algae, etc.

3. (P. O. #3)

- a. Diagram the basic structural formula of an amino acid (e.g., Agriculture: application of nitrogen containing fertilizers; Drafting, Construction and Building Maintenance: reasons behind the shapes of molecules).
- b. Using colored styrofoam balls and toothpicks, construct a model of an amino acid including labels for each type of atom (e.g., Agriculture: application of nitrogen containing fertilizers; Construction and Building Maintenance: reasons behind shape of molecules).
- c. Have students diagram the sources of nitrogen for green plants.
- d. Identify some common nitrogen-fixing organisms in both the water and on land (e.g., Agriculture: leguminous plants with nodules).
- e. Grow pea plants as follows: one set in sterile vermiculite, and another in garden soil. Inspect the root systems on each set five weeks after germination for the bacteria containing nodules.
- f. List common garden legumes suitable for local cultivation (e.g., peas, snap beans and soybeans).
- g. Invite a farmer to speak on crop rotation.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: CYCLES OF THE ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

4. (P. O. #4)

- a. Using a chalkboard, draw nitrite and nitrate molecules and explain their respective roles with green plants.
- b. Have the students list all of the food items they have consumed in the last 24 hours. Starting with the meat products listed, have the students trace the possible nitrogen pathway backwards to green plants (e.g., Home Economics: basic nutrition.)
- c. Invite farmers who grow different types of produce to discuss the types of fertilizers required by their crops.
- d. Collect various types of saprophytes from the following locations: under leaves in a forest; in a sawdust pile at a wood yard; on a slice of bread left in a sealed plastic bag; in a compost pile, etc. (e.g., Health Occupations: tooth decay; Home Economics: bacteria and fungi (mold) causing decay of food).
- e. Identify saprophytes that may be harmful (spoilage) or beneficial (garden mulch).
- f. Discuss various means of preventing undesirable saprophytes from destroying harvested crops of all types (appropriate storage techniques) (e.g., Cosmetology: proper use of cosmetics to prevent infection; Home Economics: proper storage and management of food in the home; Agriculture: proper storage of harvested crops).
- g. Plant seeds of fast growing legumes (peas or beans) in both sterile and contaminated soils. Inspect the root system after three weeks for nitrogen-fixing bacterial nodules.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: ENERGY FLOW IN AN ECOSYSTEM

GOAL

Upon successful completion of this topic, the student should be able to describe the flow of energy through an ecosystem. In addition, the student will define autotrophic and heterotrophic modes of nutrition at the cellular, multicellular, and ecosystem level.

DESCRIPTION

This topic describes the sun as the source of energy which powers the ecosystem by tracing energy conversions through several trophic levels. This is accomplished by defining the modes of nutrition as being either autotrophic or heterotrophic. These modes of nutrition are then related to types of organisms within the ecosystem's hierarchy of energy. The pyramid of energy is defined in terms of usable energy and biomass of the ecosystem.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Describe the flow of energy in an ecosystem
2. Define autotrophic nutrition
3. Define heterotrophic nutrition
4. Describe the energy relationships of an ecosystem in terms of food chains and food webs
5. Describe the flow of energy in an ecosystem in terms of the food pyramid/biomass

ESTIMATED MINIMUM TEACHING TIME: 8 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: ENERGY FLOW IN AN ECOSYSTEM

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will demonstrate an understanding of the energy flow in an ecosystem by tracing the radiant energy from the sun as it moves through the various trophic levels.

In order to do this, the student must be able to:

- a. Describe the energy requirements for the metabolic activities of organisms
 - b. Define the pathway of energy as it flows through food chains
 - c. Identify food webs as the pattern of energy flow in ecosystems
2. Following appropriate instruction, the student will define the process of autotrophic nutrition as the primary means of securing usable energy for the ecosystem.

In order to do this, the student must be able to:

- a. Define the chemical reaction of photosynthesis in terms of the conversion of radiant energy to chemical energy
 - b. Identify and describe basic plant cell structures
 - c. Compare the structure and function of leaves, stems, and roots, of green plants
 - d. Describe the percent caloric efficiency of green plants with respect to radiant energy
 - e. Identify the stored energy in green plants as the base of usable energy for the ecosystem
3. Following appropriate instruction, the student will demonstrate an understanding of heterotrophic nutrition and its relationship to the energy flow in an ecosystem.

In order to do this, the student must be able to:

- a. Describe the source of energy for heterotrophs as other organisms
 - b. Define the chemical equations of aerobic and anaerobic respiration
 - c. Identify and define the structure and function of heterotrophic cells
 - d. Define the types of heterotrophic organisms
4. Following appropriate instruction, the student will recognize the trophic levels within food chains as the pattern of energy relationships in an ecosystem.

In order to do this, the student must be able to:

- a. Describe the role of green plants as producers
- b. Describe and relate the levels of consumers in terms of food chains
- c. Identify the function of saprophytes at all trophic levels and relate their function to the ecosystem

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: ENERGY FLOW IN AN ECOSYSTEM

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES, continued

5. Following appropriate instruction, the student will demonstrate an understanding of energy flow by describing the energy pyramid.

In order to do this, the student must be able to:

- a. Define the relative percentage of usable energy in each trophic level
- b. Explain the relationship between energy and biomass
- c. Describe the loss of energy at each trophic level

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: ENERGY FLOW IN AN ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Set up classroom demonstrations of energy transfer by conduction, convection, and radiation as follows:
 - Conduction can be demonstrated by filling a metal can half full of hot water and recording the temperature change of the outside top portion of the can (e.g., Electrical/Electronics: movement of electric current through wires; Technology: movement of heat from the cylinder of an engine to the block).
 - Convection can be demonstrated by dropping a small crystal of potassium permanganate into a 1-liter beaker of standing water and then heating the bottom edge of the beaker at one point (e.g., Drafting: the movement of warmed air throughout a building; Electrical/Electronics: placement of vents above electronic boards).
 - Radiation can be observed by placing water in a black painted can fitted with a tight cover and a hole large enough for a thermometer. Place the can in direct, incoming solar radiation (sunlight) and record the temperature changes (e.g., Construction and Building Maintenance: placement and design of passive solar buildings with respect to the sun).
- b. Observe the energy released by yeast cells in fresh, nonpasteurized apple cider. Fill a thermos two-thirds full of apple cider. Add 2 grams of dried yeast. Place a thermometer and a noncontaminating gas vent in a tight-fitting stopper for the thermos. Record the temperature of the cider/yeast mixture every 8 hours for the next 3 days. Accuracy and precision measurement skills are required along with data interpretation and possible graphing of the results.
- c. Take a field trip to a local pond ecosystem. Have each student select a single organism and research its probable food source(s). Compile class data into a large food web. (It is suggested that the teacher assign specific tasks for each student to accomplish before attempting this activity.)

2. (P.O. #2)

- a. Observe the cell organelles of green plants, and describe the function of each. (Use light microscopes for observations.)
- b. Determine the amount of energy released by the combustion of a bean seed, using a calorimeter (e.g., Agriculture: plants convert radiant energy from the sun into chemical energy; Vehicle Maintenance and Repair: engines convert fuels into heat energy then into mechanical energy; Electrical/Electronics: electricity is converted into mechanical energy).
- c. Obtain living or preserved plant specimens for observation.
- d. Set up test-tube aquaria, using pond water, elodea and a small snail. Keep aquaria in sunlight to maintain growth.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: ENERGY FLOW IN AN ECOSYSTEM

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

3. (P. O. #3)

- a. Compare the structures of living or preserved heterotroph (animal) cells with that of autotroph (green plant) cells. (Use microscope to examine cells.)
- b. Diagram and compare the chemical equations of aerobic and anaerobic respiration.
- c. During a field trip to a microecosystem, have teams of students collect specimens of all trophic levels present (e.g., Producers: green plants; 1st level consumer or herbivore - plant-eating insects such as grasshoppers; 2nd level consumers - spider eating a grasshopper; 3rd level consumer - frog eating a spider).
- d. Have students identify structures which are characteristic of each trophic level (e.g., grinding teeth of herbivores, chloroplasts or green plants, canine teeth or carnivores, etc.).

4. (P.O. #4)

Have students discuss decomposition organisms found at all trophic levels (e.g., Health Occupations: bacteria causing tooth decay; Home Economics: food spoilage; Cosmetology: infected cosmetics; Food Services: clean hands).

5. (P. O. #5)

Using 1 cubic foot of soil from a hayfield, pond bank, meadow, or garden, carry out the following investigation:

- Record the temperature of the air, soil, and/or other distinguishing factors.
- Compare the soil characteristics at various depths for factors such as particle size, color, percentage of humus, percentage of moisture, etc.
- Examine the various soil layers for organisms such as earthworms, insects, larvae, etc., and place them in trophic groups.
- Determine the soil chemistry as in the topic on spheres of the ecosystem.
- Determine the types of bacteria present in the soil.

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: HUMAN ECOLOGICAL RELATIONSHIPS AND ADAPTATIONS

GOAL

Upon successful completion of this topic, the student should be able to define and relate the role of humans within the ecosystem. The student will recognize various means by which humankind has adapted to the ecosystem. In addition, the student will demonstrate appropriate conservation attitudes and techniques as they relate to human ecological adaptations.

DESCRIPTION

This topic relates Malthusian growth predictions to the current human population and the concept of carrying capacity. Common conservation practices and techniques are described as examples of beneficial human ecological adaptations. In addition, major concepts in genetics are defined as they relate to both organismal adaptations and human ecological adaptations, by means of genetic research.

SKILLS, KNOWLEDGE, AND BEHAVIORS TO BE DEVELOPED

The students will be able to:

1. Relate the concept of carrying capacity to population growth of all organisms
2. Demonstrate and/or describe the applications of basic soil, forest, water, and wildlife conservation techniques
3. Relate the role of genetics as it applies to ecologic adaptations

ESTIMATED MINIMUM TEACHING TIME: 7 hours

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: HUMAN ECOLOGICAL RELATIONSHIPS AND ADAPTATIONS

PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Following appropriate instruction, the student will demonstrate an understanding of the relationship between population and the ecosystem.

In order to do this, the student must be able to:

- a. Describe the normal growth curve in terms of an ecosystem's carrying capacity
- b. Describe the growth curve with human population data
- c. Discuss and relate the implications of Malthusian growth predictions in terms of human population

2. Following appropriate instruction, the student will demonstrate/describe applications of basic soil, forest, and wildlife conservation techniques.

In order to do this, the student must be able to:

- a. Define the applications of various soil conservation methods used in New York State
- b. Describe forest conservation in terms of ecosystem health and resource utilization
- c. Define wildlife conservation and describe the importance of preserving all species within their respective ecosystems

3. Following appropriate instruction, the student will demonstrate an understanding of the role of genetics as it applies to ecological adaptations.

In order to do this, the student must be able to:

- a. Define the gene-chromosome theory
- b. Describe various applications of genetics toward plant and animal breeding in terms of ecological adaptations
- c. Discuss current genetic research and its ecological impact for the present and potential for the future

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: HUMAN ECOLOGICAL RELATIONSHIPS AND ADAPTATIONS

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P. O. #1)

- a. Obtain and graph data concerning the white-tailed deer populations, from New York State Department of Environmental Conservation. (e.g., Health Services: bacterial colonies will multiply until some factor such as food shortage stops them; Cosmetology: the number of beauty salons in an area will continue to increase until some factor such as not enough business limits expansion.)
- b. In a 5-gallon aquarium, release three male and three female guppies. Keep records of the population size for 8 weeks and graph the results.
- c. Obtain a demographic map of the world and compare the continents of North America, Africa, Asia, and Australia. Ask questions concerning population density. (Humans have the capability to extend carrying capacity by producing the necessary food, medicine, etc., to support more people, temporarily, by technological innovations or "human ecological adaptations".)
- d. Have students research infant mortality rates for each continent. (When white-tailed deer exceed their carrying capacity there is a predictable population crash below the carrying capacity.)
- e. Have students report to the class on the topic of zero population growth. Which countries (if any) have achieved zero population growth? (e.g., Vehicle Maintenance and Repair: no new auto body shops appear in the area and those present are making money.)
- f. Invite local farmers to speak on the cost of increased crop yield.

2. (P. O. #2)

- a. Fill two identical wooden boxes 2' X 1' X 3" deep, with fine topsoil. Cover one soil surface with a layer of straw, wood shavings, or other mulch. Cut a 2-inch notch in one end of each box and elevate the opposite end approximately 6 inches. Using identical sprinkling cans, observe which box yields the most soil loss when water is sprinkled at equal rates (e.g., Agriculture: no-till planting).
- b. Using the same boxes as above, simulate contour plowing by making small furrows perpendicular to the water flow.
- c. Invite a speaker from the U.S. Forest Service. (What types of tree harvesting is allowed on U.S. Forest Service land? Who can harvest trees? How do you get a job with the Forest Service? What types of jobs are available?)
- d. Visit a local tree farm managed by a paper company. (What are the differences in yield between managed and unmanaged timberlands? How many years does it take for trees to reach harvest size?)

OCCUPATIONALLY RELATED SCIENCE
MODULE: LIFE SCIENCE APPLICATIONS
TOPIC: HUMAN ECOLOGICAL RELATIONSHIPS AND ADAPTATIONS

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

2. (P. O. #2), continued

- e. Visit a local lumber yard and get a first-hand explanation of the "grading" process.
- f. Prepare an exhibit on tree diseases common to your geographic area. Discuss ways to safely control the specific diseases.
- g. Obtain information on the endangered species of New York State from the Department of Environmental Conservation.

3. (P. O. #3)

- a. Repeat Redi's Experiment which disproved spontaneous generation.
- b. Obtain living cultures of tetrahymena from a biological supply house to observe reproduction by fission.
- c. Obtain living examples of plants characteristic of six different types of vegetative propagation, and keep them alive throughout the year.
- d. Have students start their own stem cuttings from appropriate plants, such as geraniums, ivy, coleus, etc.
- e. Demonstrate the technique of grafting and explain its advantages for fruit orchards.
- f. Visit a local community college where students are learning the technique of cloning.
- g. Obtain and plant seeds containing the recessive, lethal gene for albinism.
- h. Obtain a seed catalog exclusively for corn, and discuss the reasons for different hybrids.